Aviation Week
and Space Technology

A McGraw-Hill Publication

July 17, 1961

FAA to Test Landing Flareout Guidance System

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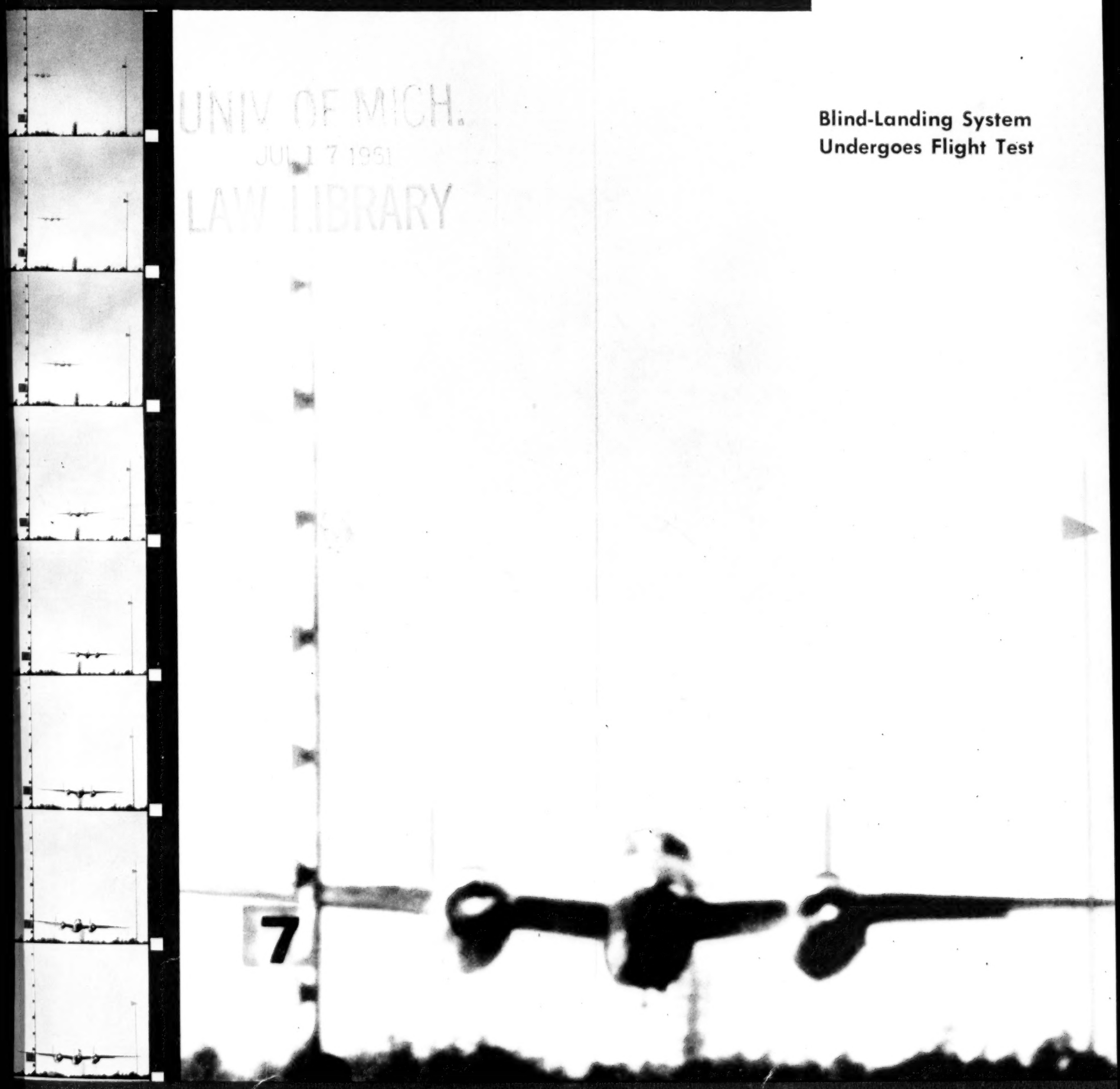
Blind-Landing System Undergoes Flight Test



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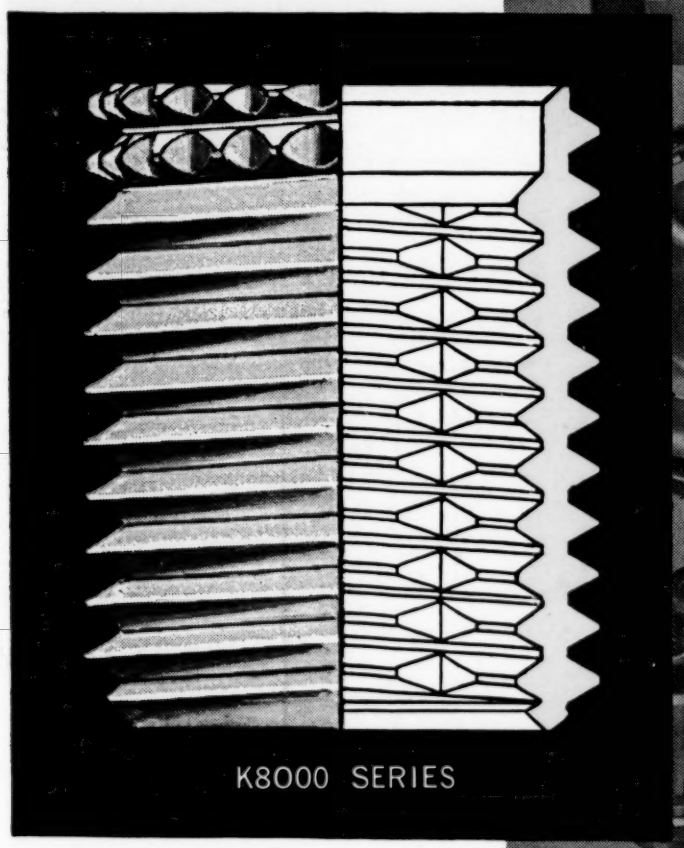

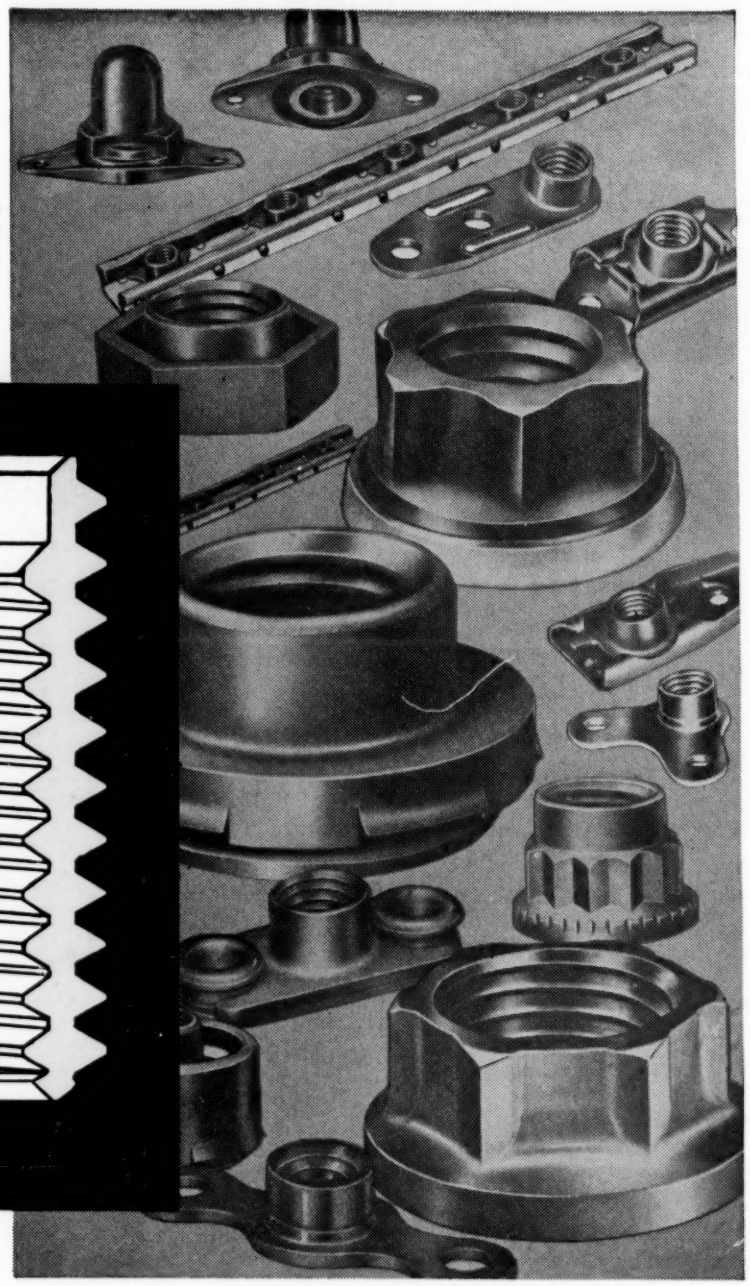

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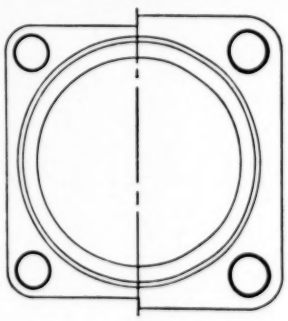

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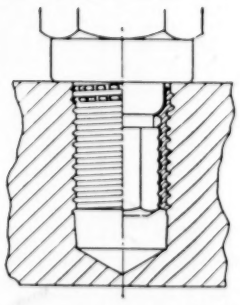

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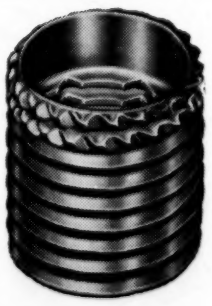

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AVIATION CALENDAR

July 24-26—Air Traffic Control Facilities Symposium, Electronic Maintenance Engineering Assn., Mayflower Hotel, Washington, D. C.

July 25-Aug. 10—International Trade Fair and Aviation Exhibition, McCormick Place Exposition Center, Chicago, Ill.

July 26-28—Annual Convention, Southeastern Aviation Trades Assn., Deauville Hotel, Miami, Fla.

July 31-Aug. 11—Conference on Physics of the Solar System and Re-entry Dynamics. For information write: Conference Director, Room 310, Holden Hall, Virginia Polytechnic Institute, Blacksburg, Va.

Aug. 1-3—Fourth Western Regional Meeting, American Astronautical Society, Sheraton-Palace Hotel, San Francisco, Calif.

Aug. 1-10—28th Annual U. S. National Soaring Championships, Wichita, Kan.

Aug. 2-4—Summer Meeting on Aerospace Applications for Hydraulic Fluids Test Methods, American Society for Testing Materials, Santa Ynez Inn, Pacific Palisades, Calif.

Aug. 3-6—North Central States' Airport Managers Conference, Mason City, Iowa.

Aug. 7-9—Guidance and Navigation Conference, American Rocket Society, Stanford University, Palo Alto, Calif.

Aug. 15-17—Cryogenic Engineering Conference, University of Michigan, Ann Arbor.

Aug. 16-18—International Hypersonics Conference, American Rocket Society, MIT, Cambridge, Mass.

Aug. 19-24—Institute of the Aerospace Sciences/Naval Aviation Meeting, San Di-

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AVIATION WEEK and Space Technology

July 17, 1961
Vol. 75, No. 3

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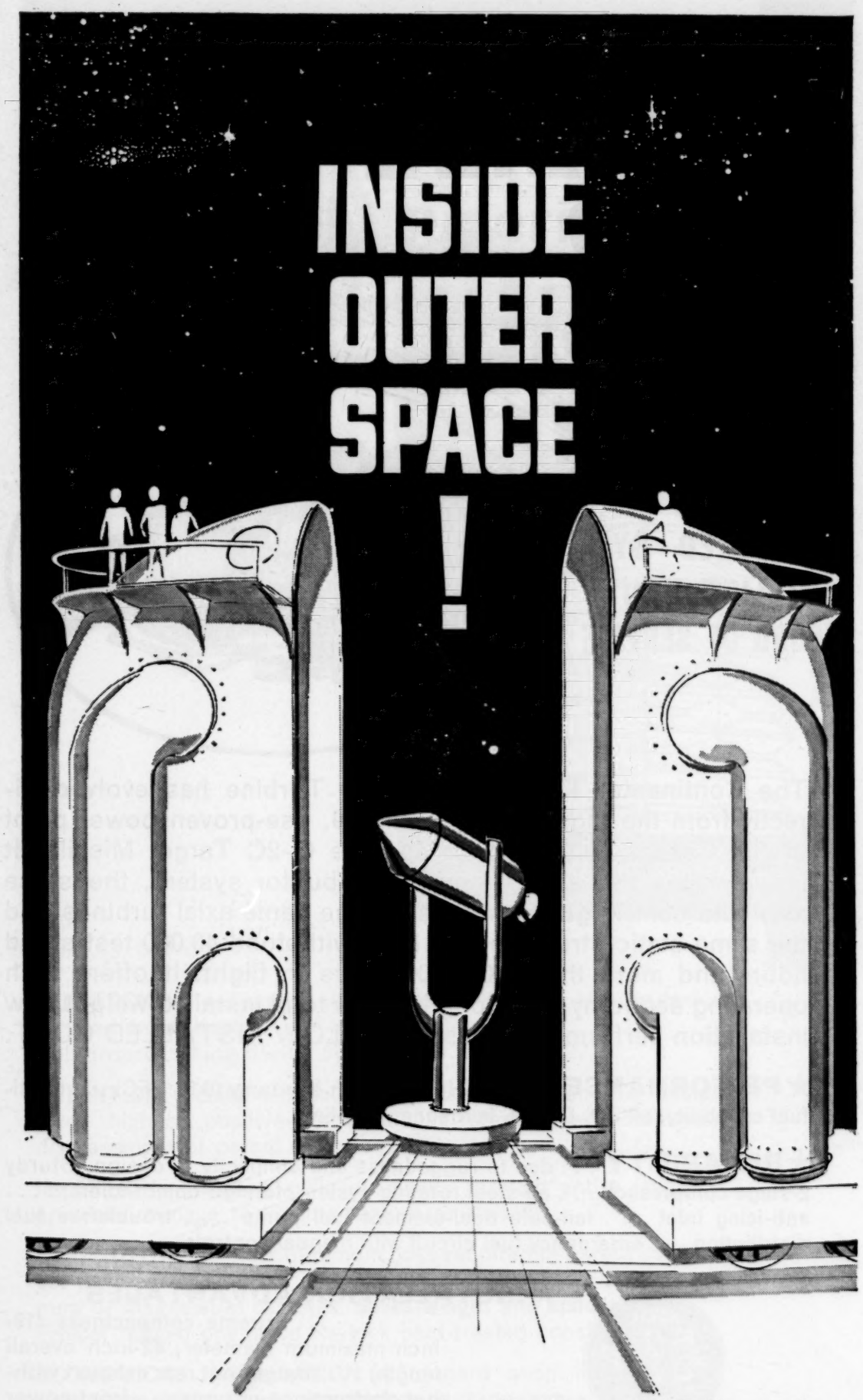

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AVIATION CALENDAR

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Aug. 22-25—Western Electronic Show and Convention, Cow Palace, San Francisco.

Aug. 23-25—Fourth Biennial Gas Dynamics Symposium, American Rocket Society, Northwestern Technological Institute, Evanston, Ill.

Aug. 24-26—Sixth Annual National Reunion, OX5 Club of America, Allis Hotel, Wichita, Kan.

Aug. 28-Sept. 1—International Heat Transfer Conference, University of Colorado, Boulder, Colo.

Aug. 30-Sept. 1—Second Annual Bionics Symposium, General Electric Advanced Electronics Center, Cornell University, Ithaca, N. Y.

Aug. 30-Sept. 1—Third Annual Semiconductor Conference, American Institute of Mining, Metallurgical and Petroleum Engineers, Ambassador Hotel, Los Angeles.

Sept. 4-10—1961 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

Sept. 4-14—Eighth Anglo-American Aeronautical Conference, Royal Aeronautical Society and Institute of the Aerospace Sciences, London, England. Wilbur Wright Memorial Lecture, Sept. 12.

Sept. 6-8—National Symposium on Space Electronics and Telemetry, Institute of Radio Engineers, University of New Mexico, Albuquerque, N. M.

Sept. 10-12—National Convention, National Aeronautic Assn., Westbury, N. Y.

Sept. 13-14—International Operations and Maintenance Symposium, Airwork Corp., Millville, N. J.

Sept. 13-15—16th Annual Meeting, Armed Forces Chemical Assn., Statler-Hilton Hotel, Washington, D. C.

Sept. 14-15—Ninth Annual Joint Societies Engineering-Management Conference, Institute of Radio Engineers, Hotel Roosevelt, New York, N. Y.

Sept. 15-17—Annual Convention, National Assn. of State Aviation Officials, Miami Beach, Fla.

Sept. 20-24—National Convention and Aerospace Panorama, Air Force Assn., Philadelphia, Pa.

Sept. 26-28—Annual Convention, National Business Aircraft Assn., Mayo Hotel, Tulsa, Okla.

Sept. 29-30—Society of Experimental Test Pilots' Fifth Annual Symposium (including a forum on the Supersonic Transport) and Awards Banquet, Beverly-Hilton Hotel, Beverly Hills, Calif.

Oct. 2-4—Seventh National Communications Symposium, Institute of Radio Engineers, Hotel Utica, Utica, N. Y.

Oct. 2-7—12th International Astronautical Congress, Washington, D. C.

Oct. 9-15—American Rocket Society's 16th Annual Meeting & Space Flight Report to the Nation, Coliseum, New York, N. Y.

Oct. 14-22—Federation Aeronautique Internationale 1961 General Conference, Hotel Quintandinha, Rio de Janeiro, Brazil.

Oct. 23-24—Joint Meeting, Canadian Aeronautical Institute/Institute of the Aerospace Sciences, Ottawa, Canada.

Oct. 23-27—17th Annual General Meeting, International Air Transport Assn., Sydney, Australia.

July 17, 1961

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COVER: Flarescan instrument landing system, developed by AIL Division of Cutler-Hammer to provide flareout and terminal glide beam guidance for all-weather landings, is shown under test at MacArthur Field, Long Island, N. Y., using Bendix B-25. Second model of the new FILS system goes to Federal Aviation Agency's Atlantic City facility this month for flight evaluation. Flagpole with calibrated markers and motion picture camera are used to check system's dynamic performance. For details of new all-weather landing system, see p. 69.

PICTURE CREDITS

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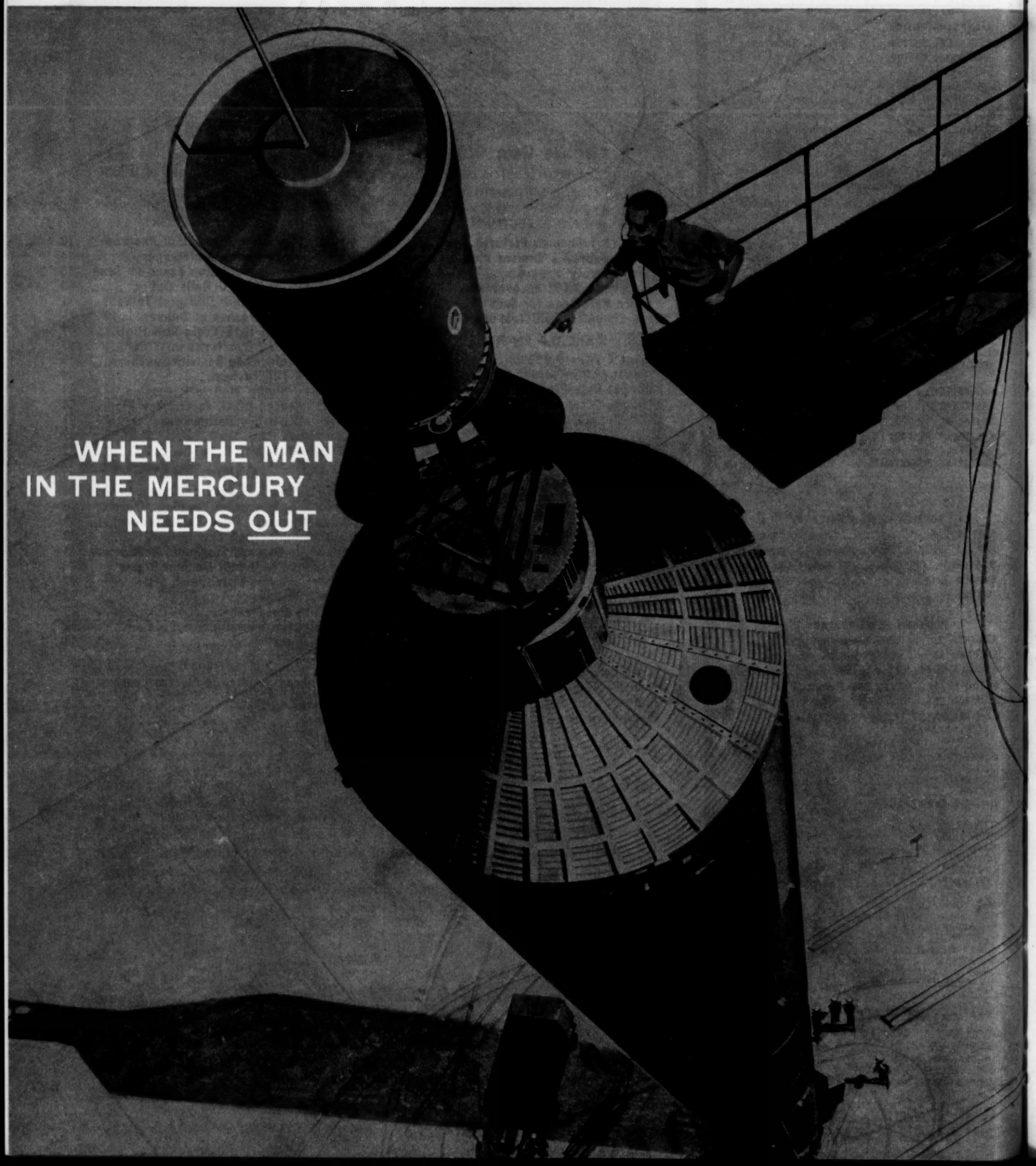


EDITORIAL

Lessons of Tushino

There are several lessons for the West to learn from the Soviet air show last week at Tushino.

First and most important is a lesson that we have failed to learn despite considerable instruction since 1955. That is simply that despite all their other problems with low standards of living, miserable housing, erratic farm production, family squabbles within the communist bloc of nations and all of the other woes and worries that beset them, the rulers of the USSR are devoting top priority to forging the most modern technologies into the most formidable military force they deem possible.

Since they gleaned the first fruits (even as did the U.S. and Britain) of Germany's astonishing wartime research and development in the post-war looting of that conquered land, the Soviets have pushed resolutely and inflexibly toward this goal. In contrast, the U.S. has vacillated between bursts of tremendous and productive achievement in these fields and intervals of slothful indifference soothed by the opiate of "eternal peace."

Tushino 1961 proved again that the Soviets have developed a tremendous capability in the modern technologies of supersonics, rocket propulsion and space technology. The new designs exhibited at Tushino, such as Beauty, Blinder and the big new Mikoyan long-range interceptors, are highly original and have no counterparts in the Western air forces.

The laws of aerodynamics are the same the wide world over, but it is obvious from this Tushino show that the Soviets have gone far past their earlier post-war exercises in copying the West (the B-29 and DC-3, for example) and are now well out on their own in every area associated with supersonic flight and modern aircraft armament and subsystems.

Although it would be hard to find a more beautiful aerodynamic design anywhere in the world than the big twin-jet Beauty, it is not really in the basic design field that Soviet progress was most evident at Tushino. True, the speeds have increased another generation into the Mach 2-plus class, and the always big jet engines are even bigger with 45,000 lb. thrust turbojets operating in the inboard nacelles of the Bounder. But it is in the refinements of the subsystems so vital to large high performance aircraft that Tushino, even with its brief "strip tease" glimpses of the latest aircraft, revealed the most significant Soviet progress.

This has been an area in which they have admittedly lagged in the past. But a trained engineer examining the photographs on pages 26-30 in this issue of AVIATION WEEK will find significant if not all-inclusive evidence that the Soviets have advanced more than a generation in airborne radar, air conditioning systems, armament and a number of the other vital subsystem areas.

Another lesson to be learned from the 1961 Tushino show is that the Soviets make their progress in orderly, relatively small increments of logical technical progress rather than with any of the super magic that we have come to demand and expect from our technicians as a substitute for consistent defense policy and adequate funding over the long pull. The prototypes that we saw first at Tushino in 1956 are now all in operational service with the minor modifications that refine any good prototype into a serviceable combat plane.

The supersonic Flashlights, both in their attack bomber and all-weather interceptor versions, obviously have been in service for some years now, as have the Fishbed, Fishpot, Fitter and Faceplate fighters. The trend from the predominantly day fighter Red Air Force of 1956 to the all-weather defensive force of 1961 is marked, and it is obvious that special measures have been taken to try to avoid the humiliating experience of having U-2s flit unopposed over the Soviet air space for years.

It will do little good for U.S. public officials to try to denigrate these Soviet achievements displayed at Tushino. We have been assured by many top public officials during the past six years that these achievements were only illusions and would in fact never materialize. But they have! And it is far too late in the game for any more of this fatuous soothing syrup.

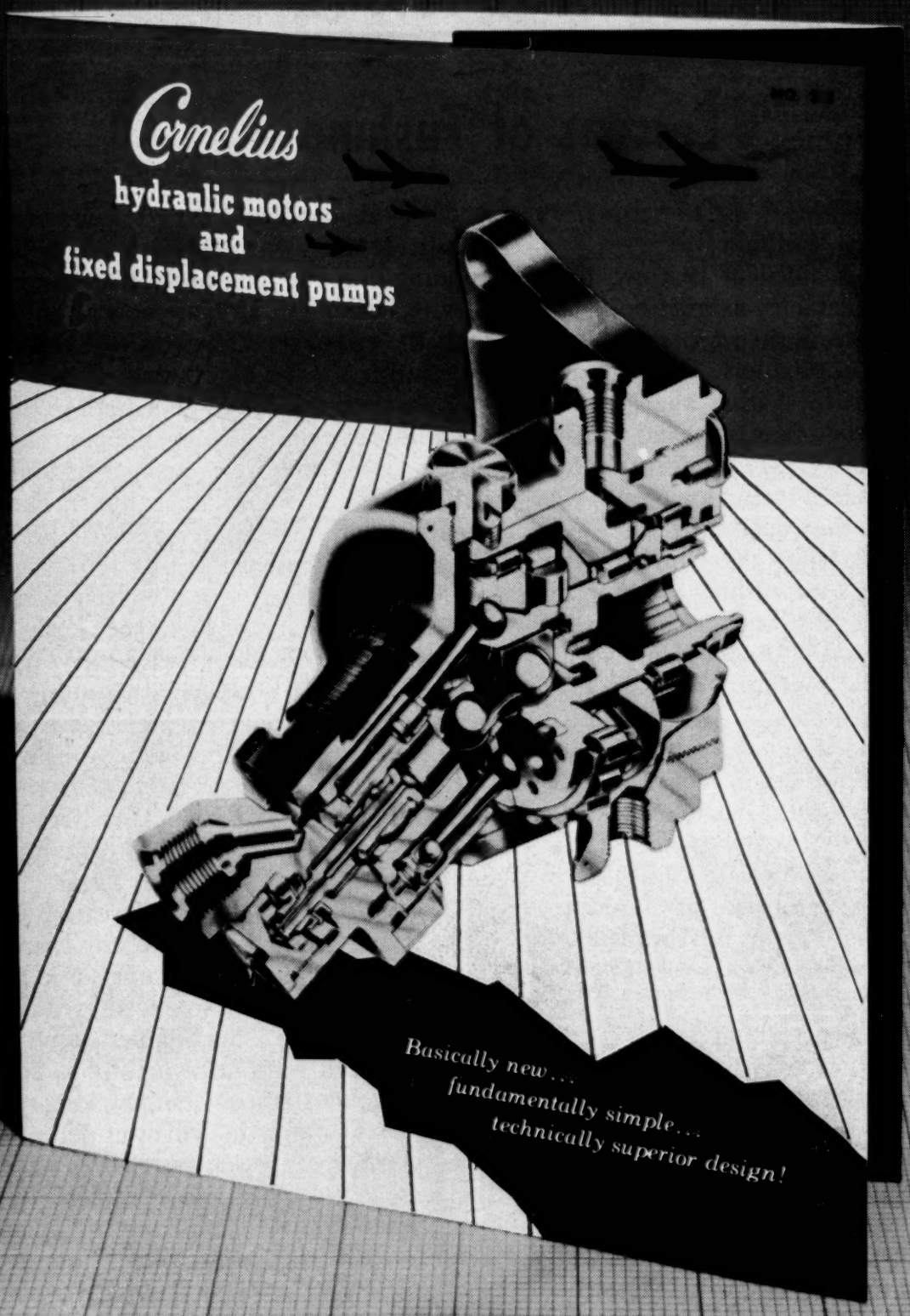
The thin line of USAF all-weather interceptor pilots will get no consolation from this pap as they ponder their task of coping with a supersonic bomber assault of Beauties and Bounders, followed by waves of Bears firing stand-off missiles. The bomber crews of Strategic Air Command will not find it helpful in solving their penetration problems against the new long-range interceptors, such as Blinder and the Mikoyan delta.

But the biggest lesson of all that we must learn from Tushino is the utter and complete folly of trying to operate a national defense on the whimsical basis of technical fads in an asinine effort to achieve solid national security without having to pay the full price for it. We have been offered "wonder weapons" that will solve all our defense problems at great economy in an endless succession during the past decade. And we have chased these technical fads without any regard to solid, across-the-board development of over-all military power.

As a result, we now face the Berlin crisis and the others that are sure to follow badly off balance in our defense structure, able to cope with only one type of crisis and ready to be whipsawed badly in any other kind or in mixtures thereof.

How we can pull this disjointed defense structure back into a solid phalanx—able to cope with today's problems today and developing the solution to tomorrow's problems for tomorrow—is perhaps the most critical problem facing President Kennedy and his "brain trust." It is difficult to see how college professors and computer operators will be able to solve these hard research, engineering and military problems in the time we appear to have remaining.

—Robert Hotz



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In the Front Office

Frank L. Magee, a director of Westinghouse Air Brake Co., Pittsburgh, Pa., replacing **Gwilym A. Price,** resigned. Mr. Magee is board chairman and chief executive officer of Aluminum Co. of America; Mr. Price is board chairman of Westinghouse.

General Dynamics Corp., San Diego, Calif., has announced the appointment of the following as senior vice presidents: **Edward J. Williams,** manufacturing, and **Robert H. Biron**-industrial relations. Appointed vice presidents: **Chester L. Meador,** contracts, and **S. E. G. Hillman,** materiel. Also: **Patrick J. Sullivan,** vice president-communication, and **Douglas A. Larsen,** assistant vice president-communication.

USAF Col. Leslie B. Williams, assigned to the Atomic Energy Commission aerospace nuclear propulsion staff for the past 3 years, has been transferred to the State Department as special assistant for space and atomic energy.

Kenneth M. Lord, vice president-manufacturing and purchasing, Raytheon Co., Lexington, Mass.

Space-General Corp., newly formed subsidiary of Aerojet-General Corp. (AW July 10, p. 79), Glendale, Calif., has announced the election of the following corporate officers: **Albert P. Albrecht,** vice president, Electronics Systems Division; **Edward R. Elko,** vice president-planning and administration; **Dr. Jack E. Froelich,** vice president-advanced systems; **Marvin L. Stary,** vice president and general manager, Spacecraft Division; **Clifford W. Snider,** secretary-treasurer.

Raymond Hamada, senior vice president-operations, Houston Fearless, Beverly Hills.

Dr. L. Curtis Foster, vice president, Zenith Radio Research Corp., Menlo Park, Calif., a subsidiary of Zenith Radio Corp.

Chester W. Nimitz, Jr., vice president, Perkins-Elmer Corp., Norwalk, Conn., and general manager of the Instrument Division. Also elected vice presidents **Henry F. Brockschmidt** general manager of International Operations; **Robert H. Sorensen** general manager of the Electro-Optical Division.

Richard T. McCauley, assistant to the president of Kellett Aircraft Corp., Willow Grove, Pa.

Dr. Stanley R. Mohler, director of the Federal Aviation Agency's Civil Aeromedical Research Institute, Norman, Okla, succeeding **Dr. Hilliard D. Estes** now chief of the Bureau of Aviation Medicine's Environmental Health Division, Washington, D. C.

Maj. Gen. Edwin B. Broadhurst, commander of the Strategic Air Command's 7th Air Division in England, succeeding **Maj. Gen. Charles B. Westover,** who will become assistant deputy chief of staff for operations, USAF Headquarters. **Maj. Gen. James H. Walsh** will succeed Gen. Broadhurst as SAC chief of staff.

Leo W. Killen, assistant to the president of Autonetics, a division of North American Aviation, Inc., Downey, Calif.

Col. Thomas J. Hayes, III, commander of the Corps of Engineers Ballistic Missile Construction Office, Los Angeles, Calif., succeeding **Brig. Gen. Alvin C. Welling,** now deputy for site activation in the newly formed Air Force Ballistic Systems Division.

INDUSTRY OBSERVER

► Air Force SOR-187 development plan (AW July 10, p. 19) calls for a VTOL aircraft with maximum ferry range of 1,200 mi. It would be carried piggyback by a C-130-class aircraft to a battlefield area where it would be launched to carry supplies to a combat site, then return to its mother aircraft. It could also ferry supply pods between mother aircraft and combat sites. Development period for the VTOL aircraft would be 5 yr.

► **Swiss government negotiations for a substantial number of Bristol/Ferranti Bloodhound 2 surface-to-air missiles are in advanced stages. Swiss talks with British Aircraft Corp. follow an order from the Swedish air force, which previously had bought a small number of Bloodhound 1 missiles. Mark 2 version has continuous wave radar, and the Bristol Siddeley ramjet has been modified for higher performance at low altitudes and shorter ranges.**

► Separation, inflation and perhaps re-entry of the stiffened Echo inflatable sphere will be observed in Project Big Shot with a television camera mounted on the front of the Thor booster, which will launch the sphere to an altitude of 800 mi. in a ballistic test flight. The booster will have a post-burnout attitude control system to keep the lens trained on the satellite.

► **Battery which weighs less than 5 lb. but can deliver 1,000 watts of power for 10 min. has been developed by the Naval Ordnance Laboratory at Corona, Calif. The new battery, which uses thin films and ammonia under pressure, has the advantage of being relatively unaffected by low-temperature operation. Melpar is designing prototype models under Bureau of Naval Weapons sponsorship.**

► India is considering ordering more Sikorsky S-62 helicopters after running into problems with the Russian Mi-4 helicopters it bought (AW Feb. 20, p. 50). The Indian air force has one turbine-powered S-62, and an order probably would involve another six.

► **First operational version of Northrop Nortronics Division's 616 Trace all-solid-state automatic test set, developed to check out Polaris missiles on submarines, is being pushed to meet a July 31 Navy-Lockheed delivery deadline. Earlier version, which is aboard the USS George Washington, is a combination vacuum tube/solid-state unit.**

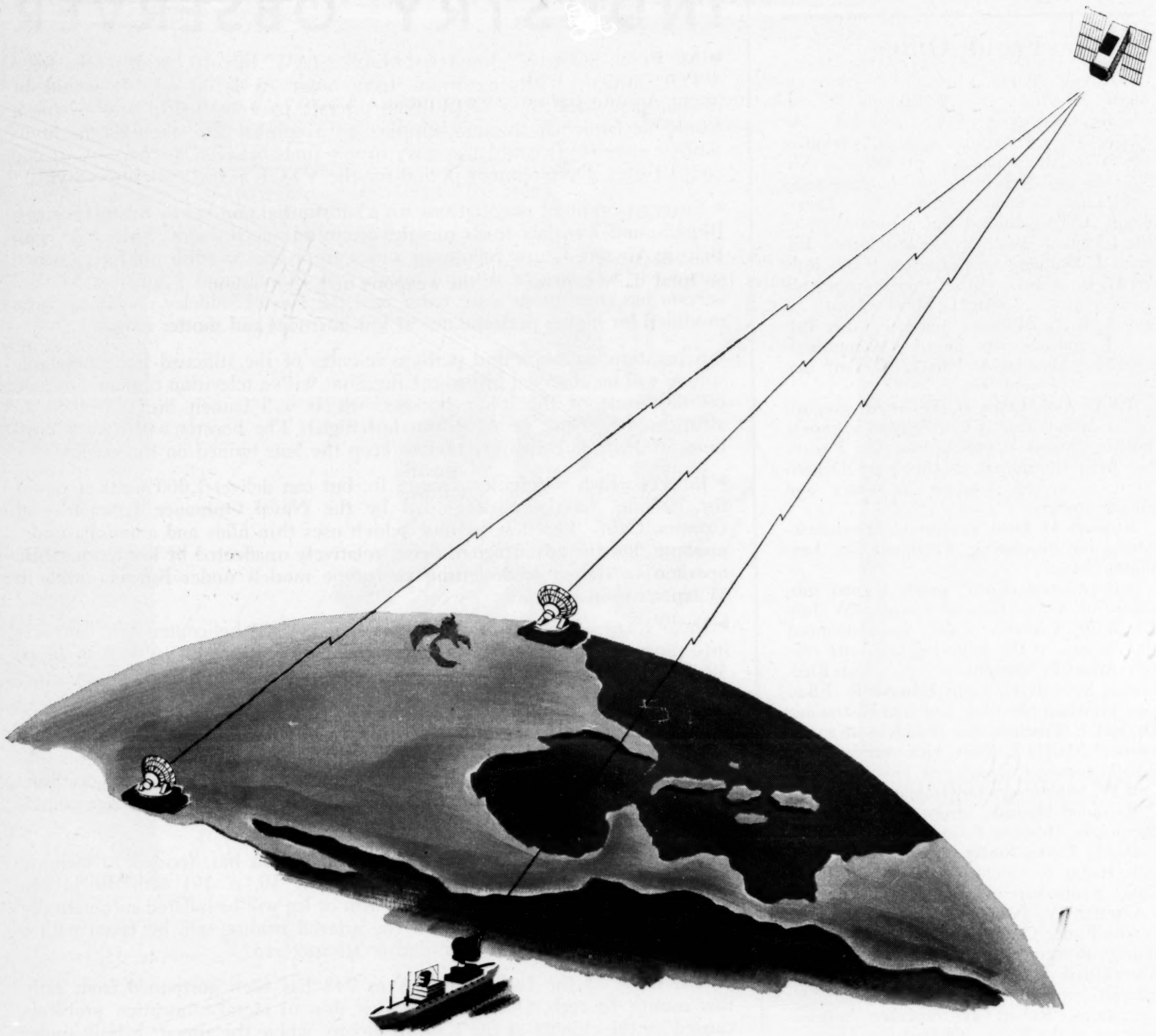
► National Aeronautics and Space Administration has decided to measure Mercury astronaut blood pressure (AW July 10, p. 19) with the proven sphygmomanometer. Cuff around an arm or leg will be inflated automatically during critical flight periods, and the arterial reading will be taken with a stethoscope, amplified and recorded or telemetered.

► **First flight of the Indian-built Avro 748 has been postponed from early this month to early October. Delay is due to metal fabrication problems caused by the climate at the Kanpur factory where the aircraft is built under license. Facilities were air conditioned to solve the problem. Operation of the 748 also must wait until its British counterpart receives its airworthiness certificate. Indians will produce a Mark I version, powered by the Rolls-Royce Dart 6, and a Mark II powered by the Dart 7.**

► Industry will submit proposals to Aerospace Corp. late in August for development of Vela Hotel satellites for detection of nuclear explosions in space. Single contractor probably will handle payload development and integration with boosters, probably Atlas Agena Bs. Atomic Energy Commission will supply radiation sensing instruments. USAF is handling the program for Advanced Research Projects Agency. Specific timetables for firings have been established.

► **Hughes Aircraft Co. has been selected by Air Force Special Weapons Center to develop special operational-type detection equipment for the Saint rendezvous and inspection satellite (AW June 12, p. 33), for which RCA is prime contractor. This equipment will be designed to distinguish between nuclear-armed, unarmed and decoy satellites.**

► Shifting the earth's orbit closer to the sun as a means of changing the earth's climate has been proposed by Soviet Professor G. I. Pokrovskiy. Power for the shift would come from thermonuclear chambers installed in underground cavities of extinct Arctic volcanoes to create massive propulsion chambers.



ADVENT OF A NEW ERA IN COMMUNICATIONS will come about through the use of wide-band microwave radio repeaters in stationary satellites. Under the over-all direction of the U.S. Army ADVENT Management Agency, Bendix is developing satellite repeaters and ground terminal equipment for the Army Signal Corps, and a shipboard terminal for the Navy Bureau Of Ships. This important participation in Project ADVENT exemplifies the new technical challenges and careers offered by our expanding Space Laboratory.

Qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

BENDIX SYSTEMS DIVISION
ANN ARBOR, MICHIGAN

THE Bendix CORPORATION

Washington Roundup

Arms Control Studies

A panel to study the economic impact of arms control and draw plans for minimizing the disruptive effects on production is being created by State Department's Disarmament Administration. It will include representatives of the President's Council of Economic Advisors and the Defense, Commerce and Labor departments, and non-government economists.

An evaluation by the Senate Foreign Relations Disarmament Subcommittee of the effect of arms limitations on 400 firms—including 140 major defense contractors—is near the final stages.

Meanwhile, the United Nations has created a panel to determine the economic implications of worldwide disarmament. Secretary-General Dag Hammarskjold estimates the total daily expenditure on weapons at $320 million.

Inability of the U.S. to detect underground nuclear weapons tests is expected to be highlighted at hearings before the Joint Congressional Atomic Energy Committee next week. Chairman Chet Holifield favors resumption of tests by the U.S.

'Survivability' Probe

Central Intelligence Agency and Air Force and Navy intelligence witnesses will lead off closed-door hearings of the Senate Preparedness Investigating Subcommittee, scheduled to begin July 18, on the status of military missile programs. Chairman John Stennis will put major emphasis on missile reliability and on what he calls the nation's "survivability." Industry witnesses will be called in a few weeks.

Secretary of State Dean Rusk and Secretary of Defense Robert McNamara will testify on steps under way to relate defense programs more closely to foreign policy objectives when the Senate Subcommittee on National Policy Machinery holds hearings, now tentatively set for next week. Chairman Henry Jackson has charged that defense programs have been based almost exclusively on strategic military considerations.

House Un-American Activities Committee is still investigating the defection to Russia a year ago of two code clerks from the National Security Agency. Several weeks after Russia downed an Air Force RB-47 over international waters, the two junior mathematicians appeared at a press conference in Moscow to denounce U.S. communications intelligence work.

Next Man in Space

Next Russian manned space flight will be in an orbit around the earth but will consist of more than one circuit, according to Soviet Cosmonaut Yuri Gagarin, who made the one-circuit flight last Apr. 12. Gagarin claimed Russia would be the next country to make a manned flight because it would not make sense for the U.S. to repeat Astronaut Alan Shepard's ballistic flight of May 5. National Aeronautics and Space Administration, which obviously thinks otherwise, plans another manned ballistic flight this week.

House space committee members would like NASA to announce that it will try to send a space probe to Venus in 1962 and have Congress adopt a resolution declaring congressional support for the effort. Rep. James Fulton, number two Republican on the committee, thinks this would help in the technological and propaganda struggle with Russia. NASA is resisting the pressure, however—at least until it can complete a study on the technical feasibility. The agency is looking into use of launch vehicles other than Centaur.

Success of ground reactor tests last May has spurred Atomic Energy Commission to prepare a proposed flight test program for the Pluto nuclear ramjet. Current program covers only ground tests.

Hitch's 'Packages'

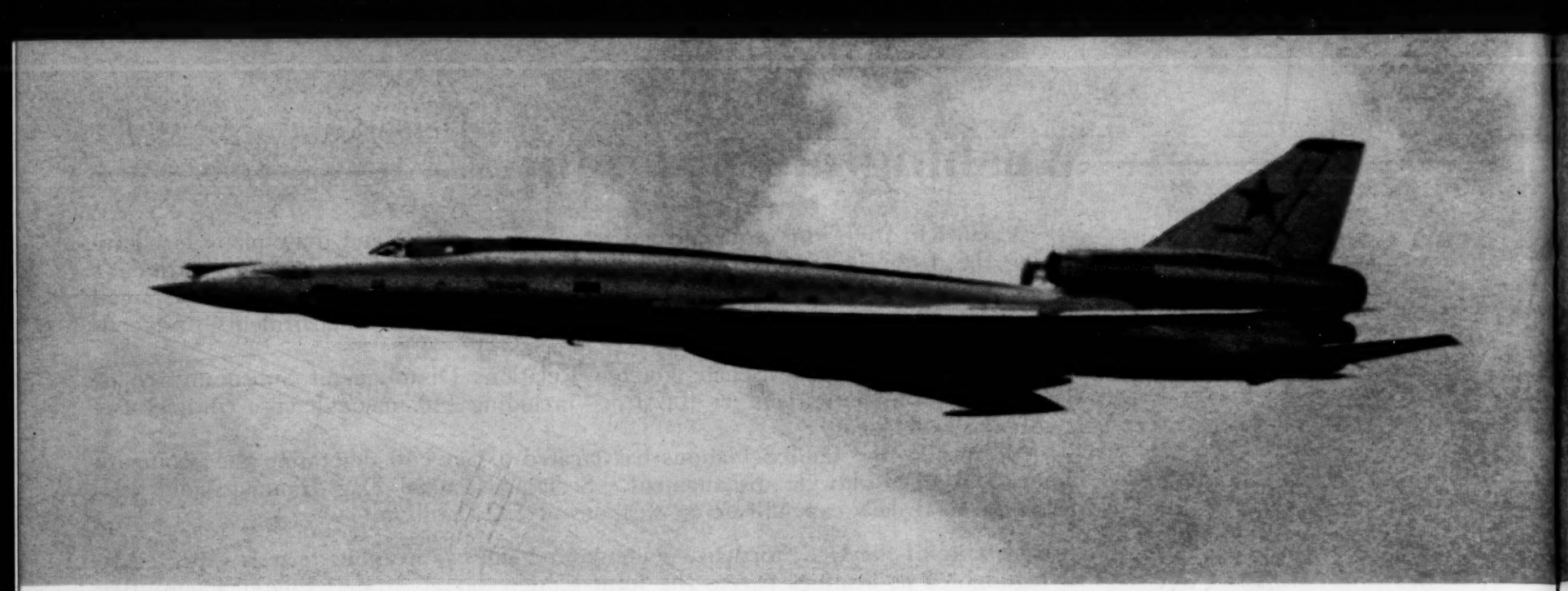
Pentagon Comptroller Charles J. Hitch has sent his "package" proposals, in which the lifetime costs of Navy and Air Force weapons programs are estimated, to the services via the Joint Chiefs of Staff. The services have until the middle of this week to prepare for meetings with the joint chiefs.

Although they are impressed by the amount of detail in the studies, the services are predicting loud cries of anguish from Congress when the vast sums required for higher priority programs, such as ballistic missiles, nuclear-powered ships and the B-70 bomber, become known.

Investigation of whether weight of the Atlas-Centaur launch vehicle can be reduced sufficiently to place Project Advent communications satellites into synchronous equatorial orbits or whether an alternate booster is needed will be concluded by Defense this month. Advent, like most satellites in the development stage has been gaining weight.

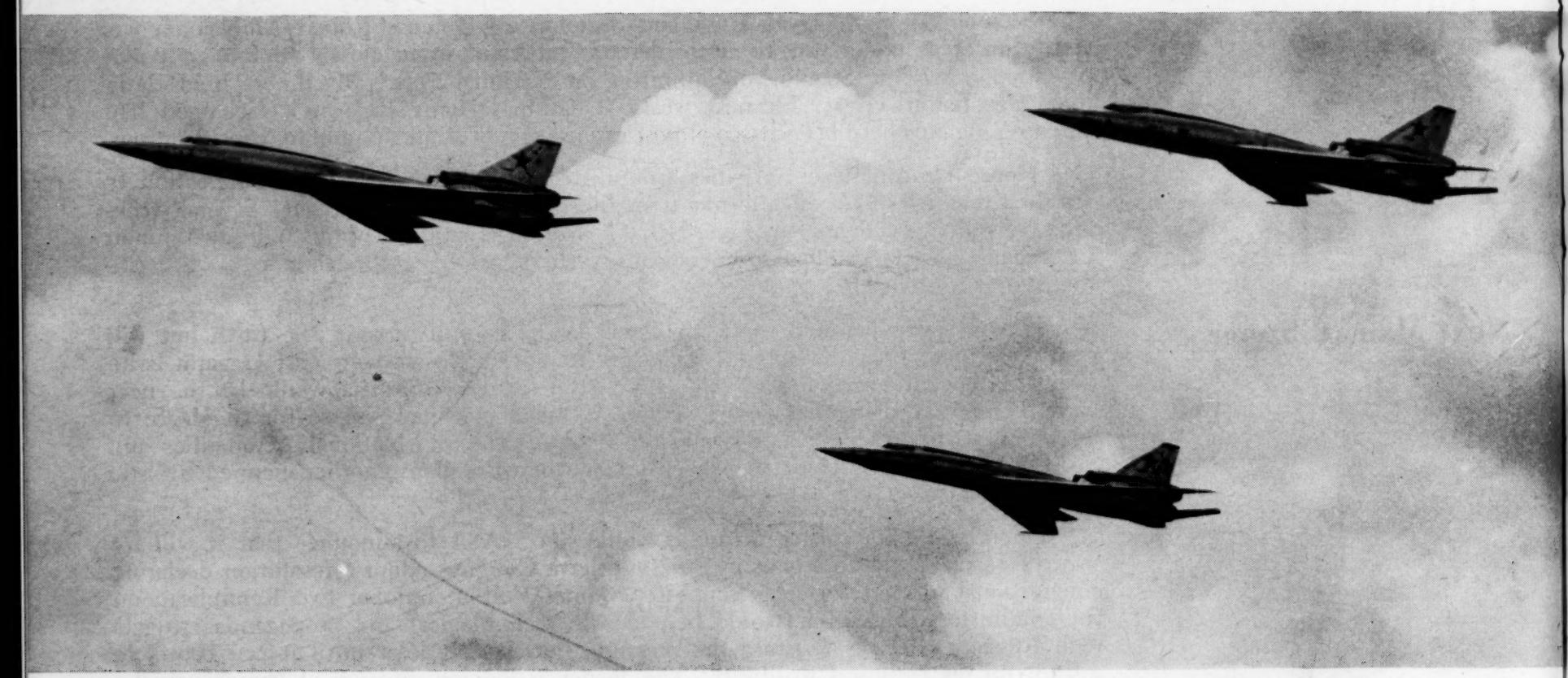
Space savings bonds now are getting serious consideration from the Treasury Department, which initially rejected the idea. Sen. Kenneth Keating who proposed space bonds, notes that NASA has received almost 50 voluntary contributions ranging between $1 and $100.

—Washington Staff

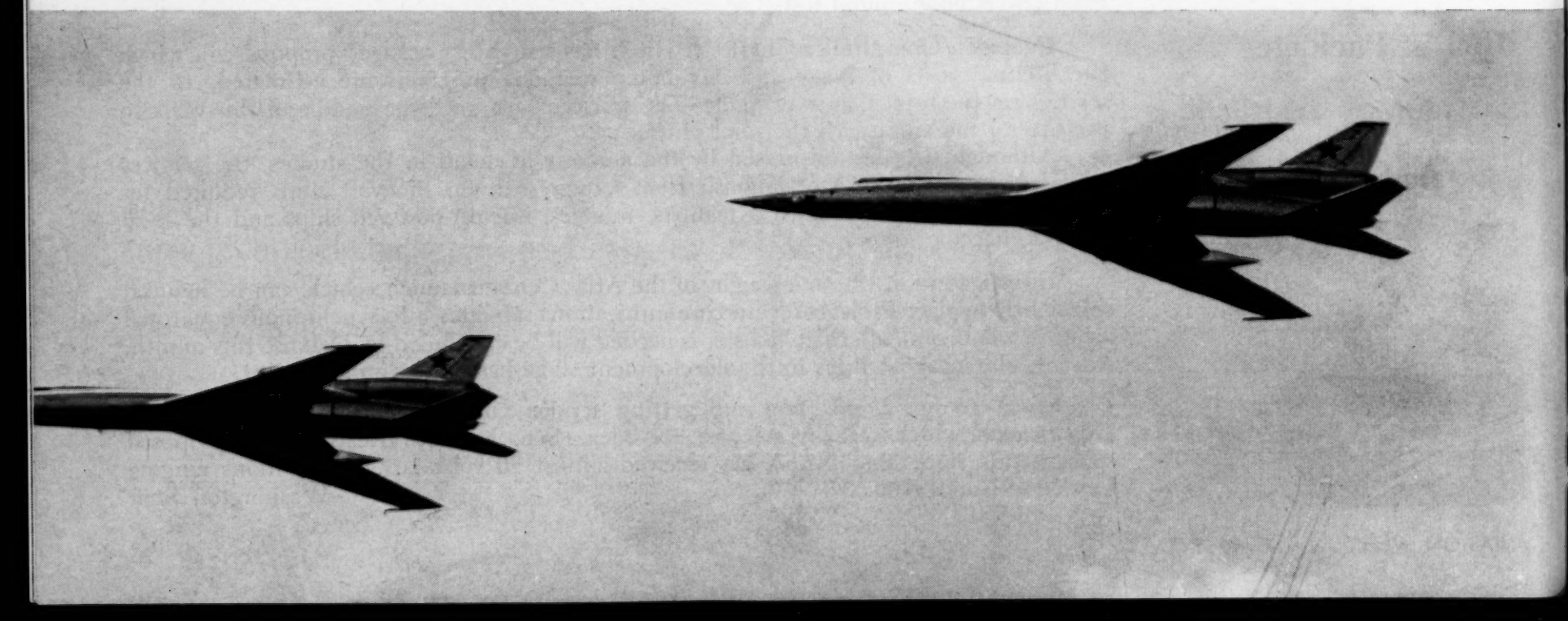


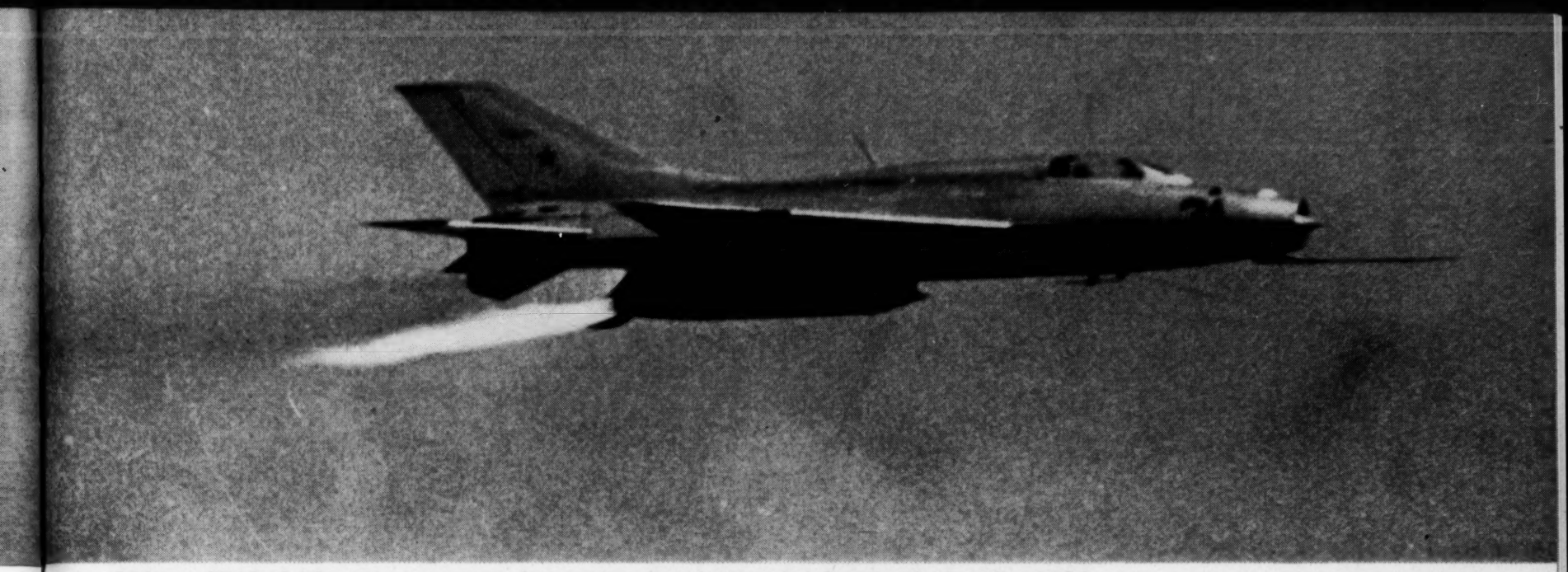
Beauty supersonic bomber shows Mach 2-plus design with retractable refueling probe visible just forward of cockpit to provide long range.

Soviets Parade New Supersonic Bombers, Mach 2 Fi



Formations of Beauty bombers indicate early operational status of this Mach 2-plus heavy bomber and reveal additional design details. Note bombing radar bulge under nose just below auxiliary air intakes. Tail radar and remotely operated turret are visible between engine tailpipe and tail fin. Highly swept thin wings house main landing gear in nacelles. Note dihedral on low set horizontal tail.

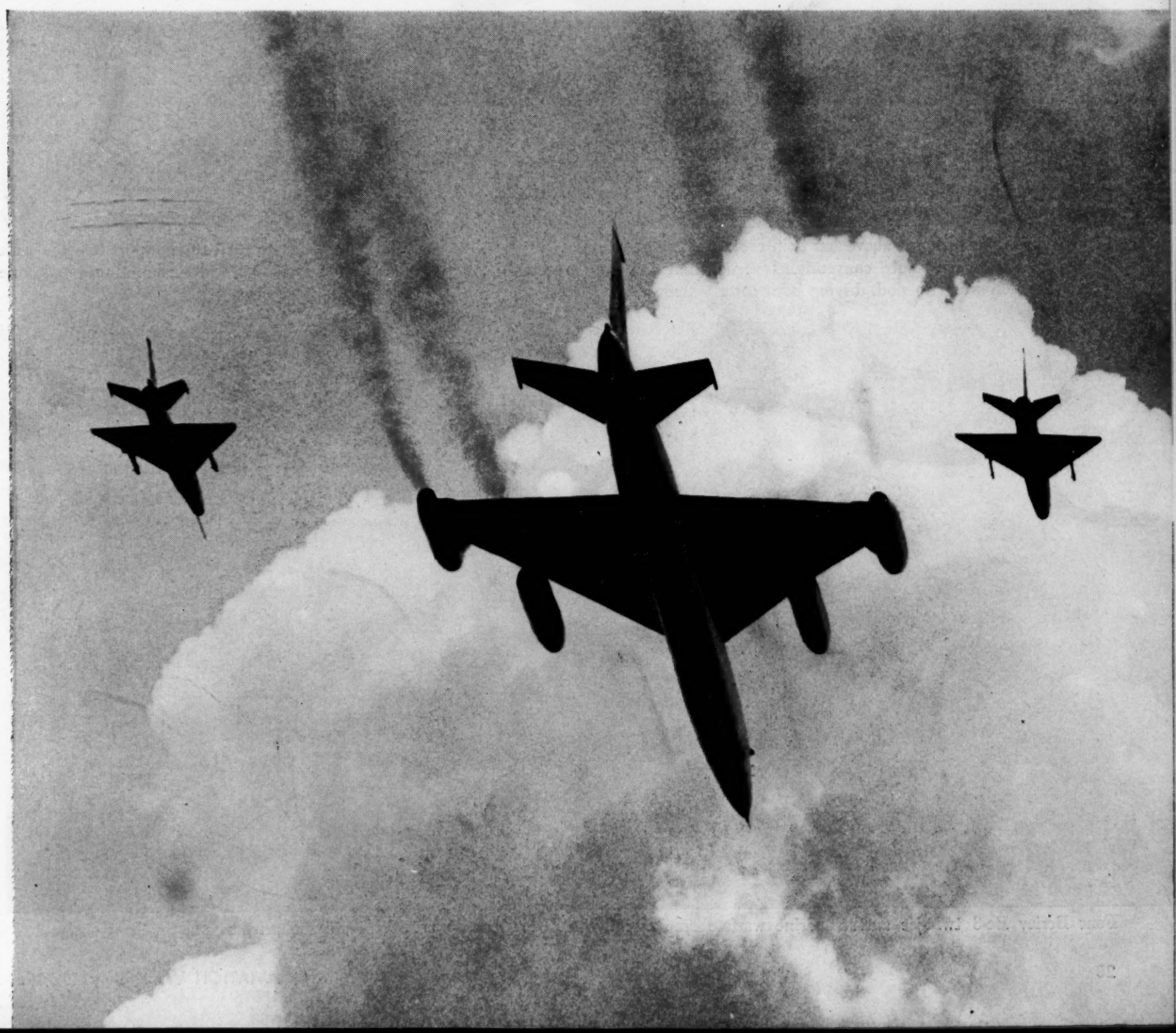




Mikoyan Fishbed delta-wing interceptor demonstrates liquid fuel rocket boost with throttle control.

2 Fighters, Jet Seaplanes, VTOL Aircraft at Tushino

Bounder flanked by two Fishbed fighters reveals new design details including much larger tailpipes on inboard engines than on wingtip-mounted outboards. Note barrel-shaped outboard nacelles and heavy fittings added to thin delta-wing to support the mid-nacelle mountings. Tail fairing indicates large drogue chute housing. Large ventral bulge runs from rear wheel well doors of bicycle landing gear rearward toward tail and mounts two pairs of stub antennas. Large bomb bay doors are outlined on fuselage belly between wing roots. Two different degrees of sweep of 80-ft. delta-wing are clearly visible.

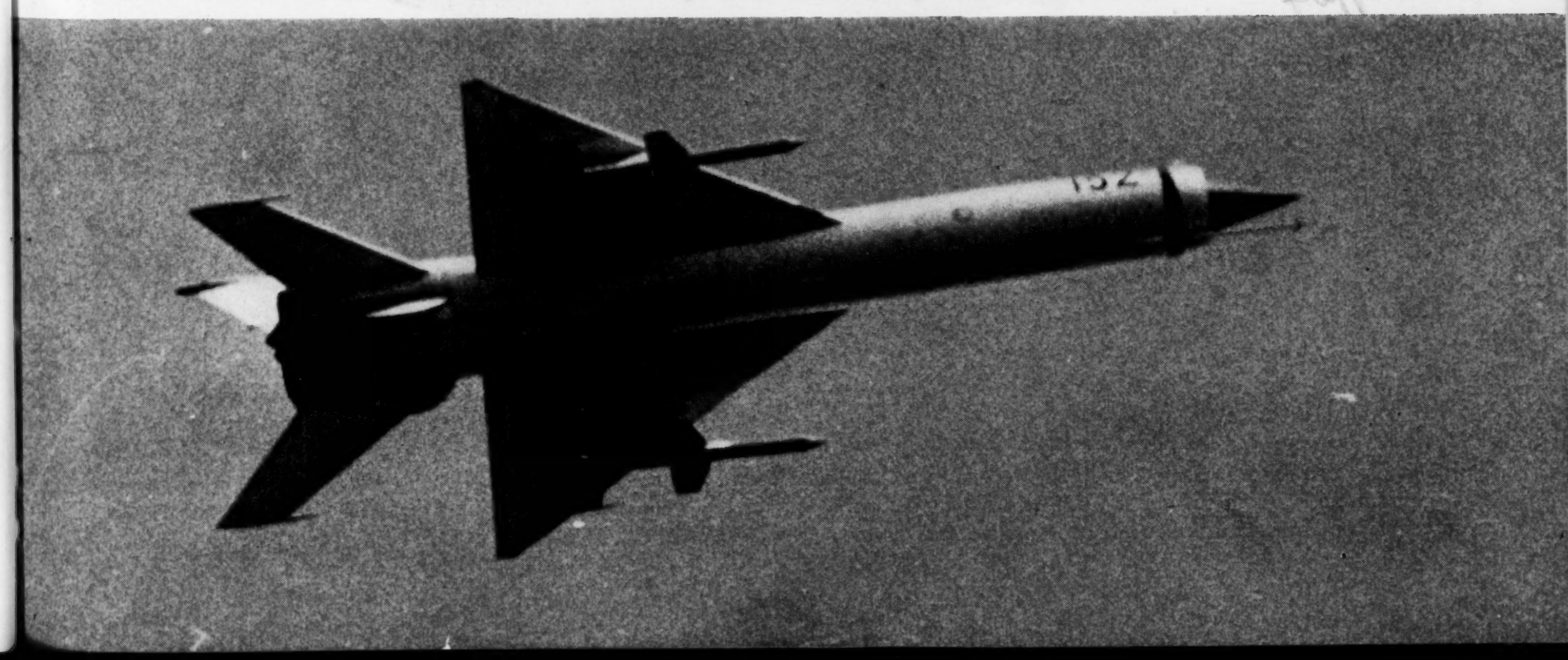


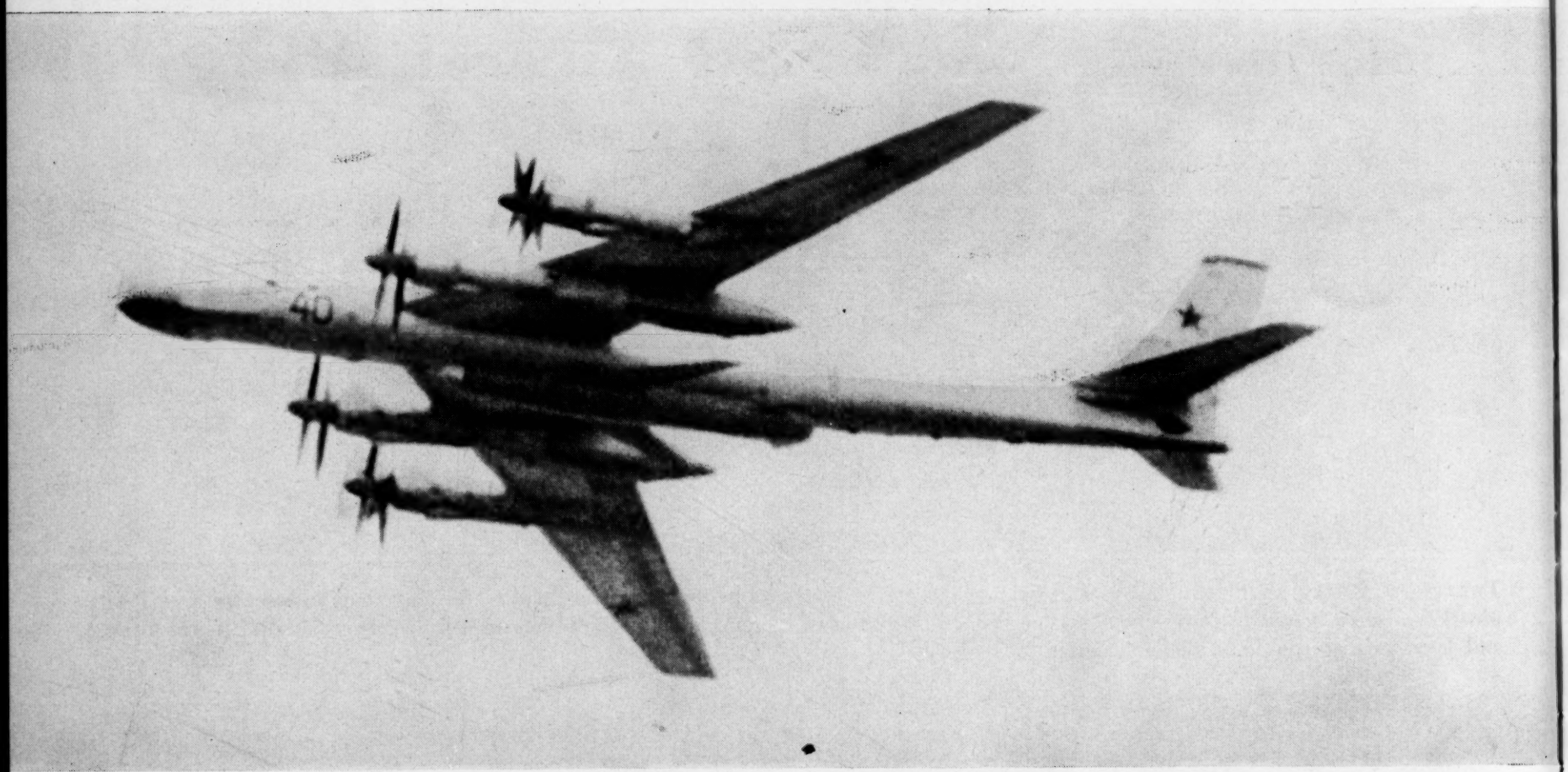
Hoop convertiplane shown above has twin rotor systems each about the size of Mil-4 rotor system and uses An-10 transport fuselage with 80-passenger capacity. Note conventional vertical tail and high-mounted wing. Powerplants are Ivchenko 4,000 eshp. turboprops, one housed in each wing tip pod, driving both rotor system and conventional propellers.

Four Beriev Be-8 twin-jet anti-submarine warfare seaplanes fly low over Tushino crowd. Note similarity to Martin P6M design.

Two views of Yakovlev Blinder (above and below) indicate Mach 2-plus performance and dual role as long-range interceptor armed with missiles or as a bomber. Note shoulder-mounted twin-jet intakes merging into single bifurcated tailpipe, large airborne radar in nose and large auxiliary fuel tank under belly.

New Mikoyan Mach 2-plus long-range interceptor (below) has large airborne radar in conical nose air intake and carries two large air-to-air missiles. This is latest development of earlier Fishbed design aimed at countering USAF bomber threat.





Bear turboprop intercontinental bomber is equipped with 300-mi. range air-to-ground guided missile slung under its specially modified belly. Note large radome nose on missile, swept wings, big fuselage denoting large nuclear weapon capacity, and large jet tailpipe. Bear nose radar has been modified for missile guidance.

Mil-6 helicopter carries what Soviets said was Vostok space ship past crowd at Tushino. Labels say USSR and Vostok, carry picture of Yuri Gagarin on nose. Large radome is visible on capsule belly and four retrorocket housings are contained in stern circular housing. Other helicopters carried earlier Sputniks and space probes in flypast.

Tushino Stresses USSR Aircraft Priority

First Soviet public air show of importance in five years unveils impressive array of Russian aircraft.

By Cecil Brownlow

Moscow--Soviet Union, displaying a wide range of design techniques, demonstrated effectively last week at Tushino that it is moving steadily ahead at near top speed in the development of manned aircraft and their related missile systems to cover all required tactical and strategic missions.

Contradicting earlier pronouncements by their leaders, which were believed by many in the West, that they had turned from production of manned aircraft to rely solely on missile systems for defense and offense, the Soviets staged their first public air show of importance in the past five years, rolling out three supersonic bombers, two new delta-wing Mach 2-plus interceptors, a jet-powered ASW reconnaissance seaplane, a convertiplane capable of airlifting 100 troops, an advanced Kamov jet helicopter design and a flying crane.

The Soviets climaxed the show at Tushino airfield in the Moscow suburbs with a series of low-level near-sonic military flybys, displaying publicly for the first time:

• **Bounder,** an exceptionally large high delta-wing bomber of intercontinental range approaching the B-36 in size and with a supersonic dash capability in the configuration shown at Tushino. The aircraft has been flown and tested with various types of powerplants for the past three years (AW Dec. 1, 1958, p. 27; July 3, p. 27). The Bounder, its design credited to a group headed by Vladimir Myasischev, has two large inboard engines slung from pylons beneath the delta wings that produce an estimated thrust of 45,000 lb. each plus two relatively smaller powerplants mounted on the wingtips. Large inboard engines of the aircraft shown here in a single flyby have an inlet diameter of about 6 ft. and are believed to be turbofans by some qualified observers, although there appears to be no visible external evidence of this. Wingtip powerplants have barrel-shaped nacelles and are mounted on extremely heavy wingtip fittings.

Bounder sported light belly paint on both the fuselage engine nacelles and flaps with a large bulging ridge running about 15 ft. along the rear fuselage just back of the rear wheel well doors of its bicycle landing gear. Two pairs of stubby sweptback antennas were attached to this bulge. The inboard engine nacelle pylons continue above the wing in a fence to curtail spanwise flow. Under the wing, the pylons of the Bounder displayed extended far beyond the engine tailpipes indicating that they may have been designed to accommodate much longer nacelles. Tailpipes of the inboard engines were almost twice as large as those of the wingtip-mounted engines on this Bounder which bore the operational number 12 on its nose.

• **Beauty, an advanced swept-wing** Mach 2.5 heavy bomber equipped with a retractable nose refueling probe whose use could boost it to intercontinental ranges. Beauty has twin-jet powerplants mounted to the rear of the fuselage along either side of the vertical tailfin. Engine nacelles, whose tailpipes project beyond the tailfin, are about 30 ft. in length. Aircraft's over-all size is slightly larger than the Convair B-58.

Beauty has a highly swept extremely thin wing with main landing gear housed in bulges at the trailing edges. It has a bombing radome under the nose and the entire fuselage has a slightly arched appearance. Cockpit indicates a crew of three and is obviously designed with a minimum of glass to hold down high speed skin heating. Two auxiliary air intakes are located on either side of the nose. Tail warning radar was visible and the horizontal tail had a slight dihedral. Dorsal ridge running from cockpit to tailfin indicated control systems housing. Beauty flew by first as a single prototype with the number "24" and then in three formations of three planes each indicating at least limited operational service and production.

• **Blinder,** a Mach 2 swept-wing design that can perform the dual role of bomber and interceptor and is believed to be an advanced development of the Mach 1.4 Backfin. Credited to designer Alexander Yakovlev, Blinder was first seen in 1959 and is powered by two turbojet engines mounted shoulder high in the fuselage with the two inlets located on either side of the fuselage just behind the cockpit. Twin exhausts for the engines are placed in the tail in a single housing. Two of the aircraft were seen in low-speed passes at Tushino.

Blinder had a large conical nose radar of extremely large diameter obviously designed for airborne interceptions and missile guidance. It carried a large delta-winged air-to-air missile under each of its highly swept wings. It also had a large bulging fairing under the fuselage that appeared to be an extra fuel tank similar to the belly fuel tank on the English Electric Lightning P.1. Cockpit indicates a two man crew in tandem. Contours of two tailpipes were visible at the rear fuselage with the horizontal tail mounted midway on the tailpipes with a ventral fin extending down on each side.

• **New Mach 2-plus long-range** interceptor that appears to be an advanced version of the delta-wing Fishbed shown at Russia's last major air show in 1956 (AW July 2, 1956, p. 26) and developed by a team led by designer Artem Mikoyan. A large single air intake is in the nose, with a conical diffuser housing airborne radar that provides all-weather capability. The aircraft appears to have three distinct tailpipes, two for the normal turbojets, the third for a large rocket boost motor. It is also believed to be the aircraft the Soviets designated the "E-66" in claiming world speed and altitude records of 1,335 mph. and 112,-294 ft. (AW July 10, p. 25). On the day of the show, the Soviet press announced that the "E-66" would be on hand, but it was not publicly identified during the display. One of these advanced Mikoyan designs was shown in a high-speed pass and limited acrobatics. It carried two large air-to-air missiles with cruciform fins, and cruciform control surfaces at the missile's tail.

• **Second Mach 2-plus fighter** also with a rocket boost system. It is a large aircraft with an over-all configuration resembling that of Fishbed and is believed to be powered by two turbine engines. Fuselage length is an estimated 90 ft. A single aircraft was displayed here.

New subsonic designs included:

• **Be-8 twin-jet seaplane** designed by veteran seaplane builder G. M. Beriev that is smaller but similar in external appearance to the four-jet Martin P6M whose development was canceled in the summer of 1959 after a total of 12 had been built, including six prototypes, two of which crashed. Engines are mounted in the high wing adjacent to and on either side of the fuselage. First prototype of the aircraft, designed primarily for anti-submarine search and kill missions, was flown several years ago, but the Tushino show marked its first public demonstration. Total of four Be-8s participated in the flyby.

• **Hoop, a turbine-powered** convertiplane, capable of transporting a maximum of 100 persons. Making use of a modified An-10 transport fuselage, this

convertiplane is powered by two turboprop engines of an estimated 4,000 eshp. located at each wingtip. Propellers connected directly to the turboprops power the aircraft in horizontal flight, while vertical lift is provided by two rotor systems of four blades, each housed above a streamlined pylon on top of each wingtip nacelle. Development of convertiplane is officially credited to veteran helicopter designer Nikolai Kamov.

• **New turbine-powered helicopter** with the same general appearance as the earlier piston-powered Kamov Ka-18 but approaching in size the larger 10-passenger Mi-4. Power is supplied by one or possibly two turbine engines housed above the fuselage. With three vertical stabilizers roughly resembling the tail of the Kaman HUK-1, the helicopter has a coaxial rotor system.

The supersonic bomber demonstrations were preceded by flights of the giant Bear Tupolev turboprop intercontinental bomber and the twin-turbojet Tu-16 Badger intermediate bomber, both carrying red-painted, radar-guided air-to-ground missile systems slung beneath their fuselages.

The Bear's supersonic missile, with a white radar nose, stubbed wings with sharp sweep, a horizontal tail, folding vertical fin and a jet tailpipe, has an estimated maximum range of about 300 naut. mi. Similar but smaller air-to-ground missiles carried by the Badgers have an estimated maximum range of between 50 and 100 naut. mi.

Boasting of Russia's aviation progress on the day after the show, Tass, the official Soviet news agency, reported that the aircraft "can launch their rockets to the target without entering the zone of the enemy's anti-aircraft defense." The missiles, the article continued, have a range of "hundreds of kilometers . . . and no defense can save their targets."

The aging Bear, whose new missile weapon system will give it an added lease on life, has been modified with a section of the underside of the fuselage scooped out to accommodate the large missile. In the flybys, a single Bear opened the bomber portion of the two-hour show with its red air-to-ground missile prominent beneath the fuselage and with an escort of seven MiG-17s. It was followed by 15 Bears and then by 15 Badgers flying in formations.

Earlier, the Soviets demonstrated the maneuverability of their short-range surface-to-surface tactical missiles when six large Mi-6 turbine-powered helicopters landed on the grass strip in front of the Soviet dignitaries on hand for the show, including Premier Nikita Khrushchev, Defense Minister Rodion Y. Malinovsky, Chief Air Marshal Konstantin Vershinin and Cosmonaut Maj. Yuri Gagarin.

Landing in groups of three, one Mi-6 carried two tactical missiles while its two partners brought in transport dollies and other support equipment. The missiles were unloaded and placed in position within a relatively short time.

Another three versions of the Hook, which reportedly was scheduled for only limited production, also were shown in the show, one of them ferrying from a cable what the Soviets reported to be the Vostok space capsule occupied by Gagarin on his orbit around the earth, another the model of a Lunik probe. These were the only two reminders of Soviet space achievements in a show largely devoted to displaying Russia's ability to wage war within the present realm of techniques.

Soviets also displayed a huge flying crane that was obviously the work of Mikhail Mil's design team. It differed from U. S. approaches to the flying crane design by retaining a personnel transport capacity in a large fuselage in addition to the cargo carrying capacity slung underneath between the long quadruped landing gear. Crane operator's station is visible just below the fuselage nose where he can observe both terrain and the cargo load.

Western observers believe the combination of personnel and cargo capacity in the Mil flying crane indicates it could be used for transporting fairly large missiles with their servicing and firing crews or several large armored vehicles with their crews and supporting troops.

In addition to a pilot's compartment considerably enlarged from the Mil-6, the crane had a large plexiglass compartment in the nose between the pilot's canopy and the crane operator's position apparently aimed at providing a number of other people with wide forward vision.

The Mil crane flew over Tushino carrying a large orange painted house about U. S. freight car size slung in the cargo position. It landed, released the house and then took off again without its load. Rotor system and powerplant installation appear similar to those in the Mil-6 but the crane carried large external fuel tanks on either side of its fuselage. Fuselage appeared to be capable of carrying 50 to 60 persons while the crane appeared to have a cargo lifting capacity of about 40,000 lb.

The Hoop convertiplane has an estimated gross weight of between 50,000 and 60,000 lb. and its fuselage appears

Russians Tie Air Show to Berlin Crisis

Moscow—Top Soviet political and military leaders used last week's display of new supersonic aircraft at the Tushino air show as a backdrop for new warnings to the West and, at the same time, ordered suspension of announced plans for reductions in the Russian armed forces.

The political parade, hinged to the present Berlin crisis, began the day before the air show and was led by Soviet Premier Nikita Khrushchev who knew what was to be seen and was relying upon maximum impact. Speaking at a Kremlin reception for recent graduates of the military academies, Khrushchev repeated his determination to sign a separate peace treaty with East Germany if necessary and warned that his armed forces "possess the necessary quantities of thermonuclear weapons, the most efficient means of their delivery—close combat, intermediate and intercontinental missiles."

He also said that, in view of the military buildup by North Atlantic Treaty Organization countries, he had ordered a $3.5-billion increase in 1961 defense spending rather than planned cuts which he said would bring the total amount to approximately $12.5-billion. Actual over-all Soviet defense budgets are never revealed insofar as real expenditures are concerned.

Khrushchev said such a move was necessary because "we cannot disregard such facts as the buildup of the armed forces in western countries, the steps to increase considerably the number of strategic A-bombers which are constantly kept in the air. The forces of West Germany are being equipped with the latest weapons and increase numerically."

At the same reception, Defense Minister Marshal Rodion Malinovsky warned that "we shall continue enhancing still further our combat preparedness, continue equipping our army with first class, up-to-date weapons because we are compelled to do so by the aggressive forces of imperialist states."

In an article in Pravda on the day of the show, Chief Air Marshal Konstantin Vershinin took pains to make a timely refutation of statements by Premier Khrushchev in the years following the first Soviet satellite in 1957 that Russia, with its missile arsenal, would no longer rely upon manned bombers. He said:

"It is only natural that with the development of a new type of weapons—rockets—some of the tasks of the air force should have been taken over by them. However, the air force continues to play a great role within the armed forces.

". . . The Soviet Union now has first-class jet planes of various designs and purposes that have no equal in the world for speed, altitude and range of flight."

to be about the size of the An-10 transport. Some observers believe an actual An-10 fuselage was used in the Hoop displayed at Tushino. Soviet announcers emphasized the Hoop's potential as a short-haul airliner but its capability as a high-density assault troop transport did not pass unnoticed.

The Hoop has two rotor systems each about the size of the Mil-4 rotors. The two rotors are mounted on a pylon which in turn sits on top of two turboprop engines mounted in wingtip pods. The turboprops look like the same type Ivchenko 4,000 eshp. engines used in the An-10 and Il-18 transports. These turboprops drive conventional propellers for forward speed and also power the two rotors for vertical lift.

The Hoop wing is mounted high on the fuselage just like the An-10 configuration and is about three quarters the span of the An-10 wing. In its Tushino demonstration the Hoop required a short takeoff run before its rotors took hold for vertical lift. Pilot's cockpit is in a plexiglass dome raised about the normal fuselage while the fuselage nose also has a large plexiglass area. Two main double truck units of the fixed landing gear are suspended from long struts attached to the wing with a nose wheel mounted under the fuselage.

In its Tushino demonstration the Hoop exhibited excellent hovering and maneuvering characteristics. This model appeared to be experimental prototype.

Two of the three new supersonic bombers are in operational service with the status of the Bounder still not clear. Beauty is apparently in production since all 10 types flown were similar down to small details and it is probably in initial operational service with some units. Blinder also appears to be in production and is already equipping some operational units. Bounder still gives the general impression of still being in the development stage particularly since it has been observed with several different powerplant configurations.

Bounder Details

In its flyby, the Bounder was accompanied by two standard Fishbeds, one on either wingtip, and, as it pulled up into a sharp climb after its low-speed pass over Tushino, the pilot cut in the afterburners of the two large inboard engines for a brief period. Afterburners of the two smaller new bombers also were turned on during climbout after their passes over the field.

Shortly after the Bounder and its two fighters passed from sight into a patch of cloud cover, two distinct supersonic booms were heard on the ground, apparently made by the accelerating Fishbed escorts.

The Blinder, which followed Bounder

MIKHAIL MIL'S flying crane design demonstrates cargo capacity by lifting prefabricated house size of a U. S. railroad freight car. Note external fuel tanks along fuselage, one tailpipe of twin-jet powerplant installation and unusual cockpit configuration. Rotor system appears to be the same as Mil-6 but transport type cabin is of a smaller diameter.

in the flyby, has an estimated gross weight of well over 150,000 lb. and a 65-deg. swept wing with a span of approximately 70 ft. Two fences on either wing-half were visible during the low-altitude passes by the two aircraft. Blinder has a low slab tail.

Soviet officials termed Blinder a "small" bomber but in its flyby it carried a high-performance air-to-air missile under each wing. This, coupled with the exceptional climb capability demonstrated during pullout, led Western observers to speculate that it will be used for both bomber and long-range interceptor roles.

The advanced Mach 2 follow-on to the Fishbed, which also carried large missiles, has a much longer fuselage than its predecessor, particularly forward of the leading edge of the 65-deg.-sweep delta wing. Although only one was flown during the air show, at least two were observed during the month-long rehearsals that preceded it.

Design Modifications

Formations of operational aircraft were also flown indicating considerable design modification and armament change over the earlier prototypes first publicly displayed at the Tushino show in 1956. Second generation Flashlights (Yak-25) appeared in two versions. The production versions of the Flashlight B all-weather interceptor were armed with two air-to-air missiles and its engines appeared to be equipped with afterburners. Flashlight C, the light bomber version, also flew in formations with operational markings and had added a ventral fin.

Both the Mikoyan Fishbed and the Sukhoi Fishpot delta-winged fighters, first displayed as prototypes at Tushino in 1956, flew in operationally marked formations of up to 21 aircraft each. They were all equipped with air-to-air missiles. Both of these fighters are in the Mach 2 class as are the Sukhoi Fitter and the Mikoyan Faceplate that use the highly swept wing approach in contrast to the delta plus conventional empennage of the Fishbed and Fishpot.

Both Fitter and Faceplate flew across Tushino in operationally marked aircraft in formations of 21 planes each. Western observers believe the two delta types are the main Soviet all-weather interceptors because of their larger airborne radar housed in their conical nose air intakes.

The swept-wing Fitter and Faceplate have only limited all-weather capability with a small radar visible at the top of their air intakes.

During the civil portion of the show, the Soviets also demonstrated two of their later transport models—the Tu-124 designed for feeder-liner service and said to be powered by two Soloviev turbofan engines and the high-wing An-24 passenger-cargo aircraft powered by two 2,000-hp. Ivchenko turboprops.

In another exhibit, a group of Antonov transports were used to drop approximately 500 military and civil parachutists onto the field in individual and group jumps. Four ancient An-2 biplanes first maneuvered over the field, with their complement of paratroopers making individual jumps. Next in line, dropping parachutists in mass drops, were three four-turboprop An-10s followed by 24 An-12s coming over the field in three-plane formations.

Two Fishbed fighters were demonstrated using rocket boost from a liquid-fueled rocket that had throttle controls. One made a takeoff from the grassy Tushino field with an extremely short run and steep climb while the other flew by at low altitude and executed an almost vertical climb after cutting in the rocket boost. On the Fishbeds the rockets are slung underneath the fuselage in what appears to be a quick modification. But on later fighters such as the giant new version of the Fishbed a rocket installation has been incorporated in the design and is housed internally between the two jet engine tailpipes. Addition of the rocket boost is an indication of Soviet concern with defensive capabilities against such extreme altitude penetration as the U-2 flights. Earlier model Fishbeds and Faceplates were unable to reach U-2 altitudes on their conventional turbojet powerplants.

Senators Push President Kennedy For Early Defense Budget Addition

By George C. Wilson

Washington—Key senators, disturbed about the Soviet military buildup pointing toward a showdown over Berlin, helped push the Kennedy Administration into an early preparation of requests for more defense money.

Partisan political considerations were ignored as powerful Senate Democrats bluntly questioned Kennedy Administration management of the defense program and announced they would call in military leaders to tell Congress directly about shortcomings in weapons and manpower. Several Senators urged more emphasis on manned bombers.

So intense was the criticism during hearings last week on the Kennedy military budget by the Senate Appropriations Defense Department Subcommittee that the Administration promised Acting Chairman A. Willis Robertson (D.-Va.) that new money requests would be detailed for the subcommittee at an early date.

Appearances Canceled

With this White House assurance, Sen. Robertson canceled scheduled appearances of Gen. L. L. Lemnitzer, chairman of the Joint Chiefs of Staff; Gen. George H. Decker, Army chief of staff; Gen. Curtis E. LeMay, Air Force chief of staff, and Gen. Maxwell D. Taylor, presidential military adviser.

Meanwhile, the Air Force was preparing a revised spending program aimed at strengthening the manned bomber force, in spite of assurances from Defense Department superiors that the force now planned is sufficient.

Sen. Robertson did not appear satisfied with assurances by Deputy Defense Secretary Roswell L. Gilpatric that the Defense Department, in consultation with President Kennedy, was reviewing military programs to make sure they are adequate.

Sen. Robertson deplored the delay in modernizing the Army and said the potential Berlin showdown "is one of the greatest crises that has ever confronted us . . . Now is the time for us to do something . . . The present situation indicates that we need to step up clear across the board on everything we are doing, with the possible exception of sending a man to the moon."

Although the majority opinion in Congress seemed to favor a military buildup, some lawmakers felt that mobilization efforts would only worsen the tense situation. Rep. Thomas B. Curtis (R.-Mo.) called the Administration's actions "pocketbook leadership that trembles and confers at every Khrushchev huff and puff and then spiritlessly offers a spending proposal as a substitute for leadership."

Some key Democratic members of House military committees said privately that mobilization talk is bad strategy which will lead Russia to believe the U. S. is not already strong enough to handle any emergency.

Before Sen. Robertson postponed the hearings, military witnesses protested cuts made by the House in Fiscal 1962 budget items. Vice Adm. J. T. Hayward, deputy chief of naval operations for development, said a $1-million cut in propulsion funds will delay introduction of a new turbofan engine and a new turboprop engine. He said "the whole aircraft development program has been suffering over the last four to five years because of the Polaris program and other competing programs."

Gilpatric said the Defense Depart-

ment review was prompted by Premier Khrushchev's announcement that Russia would increase its military spending, not by the Moscow air show (see p. 31). The review was ordered July 8, Gilpatric said, the same day Khrushchev said the Soviet military budget is going to be increased in 1961 by 3,144,000,000 rubles to 12,399,000,000.

At a press conference July 11, Gilpatric said the latest Defense Department review "is directed primarily at the preparedness measures which could be taken in the near future–in a matter of months– looking toward strengthening the posture of our conventional forces.

Both before the Senate subcommittee and at his press conference, Gilpatric declined to estimate how much more money the Defense Department would request, if any. But there were indications that a sizable increase would be sought and bomber production would be increased. Sen. Robertson repeatedly told Gilpatric that his subcommittee wanted to receive any requests for more military money before it acts on the appropriations bill. Otherwise, Sen. Robertson said, the Senate would not know how much money would be available for less urgent domestic programs.

Commenting on how the Defense Department views the Russian air show, Gilpatric said it "demonstrates to us what we had heretofore believed: namely, we did not take seriously Khrushchev's statements that he was counting manned bombers as obsolete and he was going to rely entirely on missiles . . . It shows that the Soviet is doing what we are doing . . . They are going to maintain a manned bomber threat that will be a threat to us for the rest of the '60s."

Gilpatric said that the "over 600" B-52s and the "over 100" B-58s that the U. S. will have between 1962 and 1970 "are sufficient to give us a manned bomber strength throughout the 1960's."

No B-70 Change

He said the Soviet air show had not changed the Defense Department's stand on the B-70 program: "We still believe our present program for the B-70, which is a development program, gives us the flexibility we need. We do not think we should change it again . . . We want to have the bomber and system tested before we decide whether we want to order that aircraft in quantity," Gilpatric said.

But Senators Howard W. Cannon (D.-Nev.), Clair Engle (D.-Calif.), John Stennis (D-Miss.), Symington (D.-Mo.) and Ralph W. Yarborough (D-Tex.) contended the Defense Department should put more stress on manned bombers.

Tiros III Transmits Pictures, Infrared Data

Washington–Tiros III weather satellite launched successfully July 12, is transmitting clear, tape-stored pictures of the earth's cloud cover on command and is sending infrared radiation data continuously.

Teams of meteorologists at the Pacific Missile Range and Wallops Island, Va. readout stations are analyzing the photographs and heat data and transmitting the results by high resolution facsimile and teletype to the National Meteorological Center at nearby Suitland, Md.

Tiros data is combined with other information and incorporated in the regular Weather Bureau six-hour analyses which are transmitted world-wide by civilian and military communications networks.

The minitrack station at Santiago, Chile was used for the first time by having it start the satellite's camera timer. The two identical wide angle cameras (AW July 10, p. 30), duplicated to provide redundancy, were working perfectly right after launch, and the 500-line scan videcon system was operating normally. The Tiros III data is being reduced and integrated in 3 hr.–compared with 5-6 hr. for Tiros II.

NASA believes that the poor performance of the wide angle camera in Tiros II was due to the lens being damaged by third stage exhaust gases. In Tiros III, a phenolic shroud was installed to protect the lenses.

Dr. F. W. Reichelderfer, chief of the U. S. Weather Bureau, said last week that international cooperation with about 100 countries, including Russia, will be initiated if the successful transmissions continue.

Tiros III was launched on a schedule which would place it in daylight over the northern hemisphere during the height of the hurricane season in September. The satellite will alternate between hemispheres in daylight every four weeks. Tiros II is expected to fill in some of the northern hemisphere daylight time. If it fails, its transmitters will be turned off. Solar cells in Tiros II are working normally, but the batteries are showing signs of wear.

Apogee of Tiros III is 450 mi., perigee is 425 mi., the inclination is 48 deg. and the orbital period is 100 min. There will be three more Tiros launches before the Nimbus satellite launch series is started from Pacific Missile Range with polar orbits.

Sen. Cannon said the B-70 program should be placed on a "crash basis" and recommended spending $575 million in Fiscal 1962 on its development–the amount the Air Force originally requested. The Kennedy Administration budget calls for $220 million for the B-70 in Fiscal 1962. President Eisenhower had asked for $358 million.

Sen. Engle recommended that the Senate subcommittee add a provision to the House-passed appropriation bill authorizing the secretary of defense to use for the B-70 up to $138-million from the total $525 million authorized for long-range bombers. The House-passed appropriation bill–separate from the authorization bill–provides $448.8 million for procurement of long-range bombers (AW July 3, p. 26). He said if Congress could not persuade the defense secretary to use the $138 million to speed development of the B-70, the money then could be used for the B-52.

Sen. Stennis urged the defense secretary to speed the B-70's development, while Sen. Symington said failing to do so will mean the U. S. is "abandoning the field in which they [the Russians] have just demonstrated they have been concentrating on for some time." Sen. Symington said "the entire question now of what we are doing in the Mach 3 field should be reviewed."

Sen. Yarborough recommended production of more B-58s, arguing the bomber can be modified to provide the firepower of a B-52. He said the $3-billion worth of tankers built to refuel strategic bombers could be used to increase the range of the B-58.

The Kennedy Administration did not request any new Fiscal 1962 money for the B-52 or B-58. But the House voted $448.8 million in its appropriations bill for long-range bombers without specifying which models should be built. Sen. Symington said the authorization bill provides that the bomber money can only be spent for long-range bombers–the B-52 or B-70, but not the B-58.

Advertising Restrictions

A portion of the Senate subcommittee hearings was devoted to the restriction in the House-passed defense appropriations bill concerning advertising by government contractors. The House bill states: "No part of the funds appropriated herein shall be available for paying the costs of advertising by any defense contractor, and such costs shall not be considered a part of any defense contract cost."

Gilpatric said the Defense Department is "sympathetic to the purpose" of the section but felt "it is too sweeping as now worded." He recommended allowing reimbursement for "(1) recruitment of personnel, (2) obtaining scarce items, or (3) disposing of scrap or surplus materials." Gilpatric said the advertising restriction would apply only to cost-reimbursement contracts and not to fixed price contracts.

Broad Space System Participation Plan Expected From Space Council

Washington—National Aeronautics and Space Council was expected to send to President Kennedy late last week a recommendation that an independent consortium be formed to operate a commercial communication satellite system, with ownership open to aerospace companies as well as communication common carriers.

If the President concurs with the recommendation, it would become national policy.

The council will recommend strong safeguards to assure all companies an opportunity to bid for system hardware production.

Agencies in Agreement

Representatives of nine interested agencies had agreed on a coordinated policy recommendation by mid-week to be submitted to the national space council.

These agencies included the Defense Department, State Department, National Aeronautics and Space Administration, Atomic Energy Commission, Federal Communications Commission, Justice Department, Office of Civil Defense Mobilization, Budget Bureau and the President's Science Advisory Committee. The first four are represented on the space council, and nonmember agencies were expected to be invited to sit in during council deliberations.

Other Developments

Other developments in the commercial communication satellite situation included:

• **Sen. Russell B. Long (D.-La.),** chairman of the Senate Subcommittee on Monopoly, announced that he would oppose handing over control of space communications "to a very few large corporations whose present position in this field already has been achieved largely through research financed by American taxpayers." Sen. Long said that the question "is not an established routine matter to be decided by an executive or regulatory agency of the federal government. Rather it is a major public policy question which properly should be settled by the Congress."

• **House Science** and Astronautics Committee resumed its hearings on commercial communication satellites last week. Scheduled to testify were NASA, State Department, Defense Department, FCC and OCDM.

• **Federal Communications** Commission asked American Telephone & Telegraph Co. to "proceed at once" to make a cost study for the FCC which will disclose current level of earnings on the company's overseas communication services. FCC, which made a similar request nearly a year ago, rejected AT&T's earlier response that such studies would be of little value because of the rapidly changing complexion of overseas business due to new cable projects and the advent of communication satellites.

• **Officials from AT&T's** many individual operating telephone companies were reported to have visited Washington to contact their senators and congressmen to clarify AT&T's position on communication satellites and mend congressional fences. A company spokesman told AVIATION WEEK that some officials were in Washington, but pointed out that their visit was occasioned also by several bills of interest now pending, including bills dealing with wiretapping, communication facilities sabotage and a bill that deals with the use of telephone facilities for gambling.

'Early Spring' Progress

Design of Navy space mine concept, "Early Spring" (AW Mar. 13, p. 75), has reached the stage where major equipment is nearing the test stage.

"Early Spring" is planned as a vertical interceptor satellite containing an optical scanning system capable of discriminating between stars, known harmless or friendly vehicles and suspect orbiting objects.

The system will have capability of identifying its target and relaying data to the ground for positive control of destruction, if desired.

It can include capability for destruction of a target by aligning itself in a near-collision head-on orbit, with destruct achieved by using a proximity-sensitive device to make direct collision unnecessary.

Among "Early Spring" equipment nearing test stage is the detector-tracker (guidance head) of the terminal guidance and control system which, within the next few weeks, is to be installed in a simulator for checking its accuracy. The optical system will use a wide beam for initial scanning of suspect area—will then narrow the beam for precise tracking of suspect and guidance. Optical system is said to be so sensitive that it will be able to pick up a pinpoint target in the test room so small that it would be scarcely visible to an observer who would have to have precise location shown to him.

New Beech Lightplane

Fabrication of the first prototype of Beech Aircraft Corp.'s new light four-place business and utility airplane, to be priced in the $12,000 class, has been started at the company's Wichita, Kan., plant, with the airplane expected to start its flight test program before year-end. Indications are that deliveries will begin late next year.

The new airplane (AW Feb. 22, 1960, p. 95), will have a fixed tricycle landing gear. Indications are that the company has been shooting for a price of approximately $10,500.

Research, Education Spending Boost Urged

Washington—U. S. must increase its spending for science and engineering education and for basic research in universities from $3 billion this year to an annual rate of $8.2 billion by 1970 to maintain a base for scientific progress, according to a National Science Foundation report.

The report, Investing in Scientific Progress, says the federal government has a "special responsibility for leadership" in this area and that its proportion of total financial support must rise.

In Fiscal 1961, the nation's basic research effort totaled $1.8 billion, half of which was spent with universities. The federal government contributed 60% of these funds, 22% came from industry and 6% came from nonprofit institutions. The remaining 12% was contributed by colleges and universities.

Basic research programs at universities will cost $878 million this year and will involve the equivalent of about 45,000 full-time professional personnel, plus 35,000 support personnel. The report forecasts 1970 spending of $2.72 billion, with a professional force of 85,000 and a supporting force of 65,000.

This year, there are about 100,000 professional scientists and engineers teaching about 645,000 university students in these fields. The report predicts there will be 175,000 teachers and 1.13 million science and engineering students in 1970. Supporting staff would rise from the 1961 equivalent of 100,000 full-time employes to 175,000 in the same period.

Total cost of this education effort is about $2.14 billion this year, and the report says it should rise to $5.54 billion in 1970. It says that "far more" classroom space will be needed for teaching science and engineering at the university level and that an investment of about $3.5 billion is required over the next ten years.

Discoverer XXVI Recovered in Air

Re-entry capsule of USAF Discoverer XXVI polar orbit satellite with a load of materials test specimens was successfully recovered by air-snatch on its 32nd pass while other instrumentation remaining in the orbiting Lockheed Agena B continued to telemeter data on cosmic radiation and radio frequency noise from space.

Capsule, recovered 60 mi. northwest of the island of Kauai, Hawaii, contained samples of silicon, iron, bismuth, yttrium, magnesium, nickel, lead, and uranium. They were exposed to the environment of space for 50 hr. 36 min. The effect on silicon is of particular interest to the space program because it is used in photovoltaic solar power cells. Proton impingement is known to alter the crystal structure of silicon.

Project Discoverer officials calculate that the Agena B satellite will remain in orbit for between 80 and 100 days. The instrumentation and transmitters are battery-powered and the batteries will run down before re-entry. The satellite has a period of 95 min. with perigee of 146 mi. and apogee of 501 mi.

Instruments to measure the density and effects of ions and micrometeoroids at orbital altitude include an impact detector and a tuned piezoelectric crystal erosion gage. The crystal controls the operating frequency of a transmitter which shifts as erosion changes the dimensions of the crystal. By measuring the frequency shift it is possible to determine rate of erosion.

Fleet Commanders Appointed by Navy

Washington—Rear Adm. David L. McDonald, currently commander of the Navy's Carrier Division Six, will become vice admiral and commander of the Sixth Fleet, and Vice Adm. John McN. Taylor, commander of amphibious force, Atlantic Fleet, will become commander of the Second Fleet.

Rear Adm. Alfred G. Ward, assistant chief of naval operations (fleet operations) will replace Adm. Taylor with the rank of vice admiral. Vice Adm. Claude V. Ricketts, former commander of the Second Fleet, has been nominated as vice chief of naval operations.

Adm. Charles R. Brown, commander-in-chief of allied-forces, southern Europe, will retire Jan. 1, and Vice Adm. Frederick N. Kivette, commander of the Western Sea Frontier, will retire Oct. 1.

Vice Adm. Robert Goldthwaite, chief of naval air training, will replace Adm. Kivette and will be replaced by Vice Adm. Fitzhugh Lee, who is now serving as deputy commander-in-chief and chief of staff, Atlantic Fleet.

Vice Adm. Wallace M. Beakley, deputy chief of naval operations (fleet operations and readiness), will replace Adm. Lee, and Vice Adm. Herbert D. Riley will replace Adm. Beakley.

AEC Plans to Build Snap Test Facility

Washington—Atomic Energy Commission plans to build a $3.4-million facility for testing complete power units of Snap reactors before their use in space.

The Joint Congressional Atomic Energy Committee authorized the project to be built at Santa Susanna, Calif., with the recommendation that space tests and space applications of Snap power units "be carried out without delay. The superiority of such nuclear power supplies to either chemical or solar power supplies provides an excellent opportunity to increase the value of our space vehicles."

The committee noted that a 4,200-hr. test of a Snap reactor was completed "successfully" last year and that the electrical generating machinery which eventually will be coupled to the reactor was test operated for 2,500 hr. Mating of the reactor and electrical machinery is scheduled for this year.

Complete F-1 Engine Test Firings Begun

Canoga Park, Calif.—First test firings of a complete self-cooled NASA-Rocketdyne F-1 engine have begun at Edwards Rocket Test Center, Calif.

Thrust in tests is being gradually built up to the rated level of 1.5 million lb. with a 2.5-min. burning time. A thrust of 1 million lb. has been obtained in the first firings of the series.

The F-1 is being developed for the NASA Nova launch vehicle in which eight of the engines, burning kerosene and liquid oxygen, will be clustered to provide a total of 12 million lb. thrust.

Atlas E Flies 9,050 Mi.

Washington—USAF-Convair Atlas E made a successful 9,050-mi. flight from Cape Canaveral, Fla., into the Indian Ocean on July 7. The E model previously had a record of seven failures in 10 launch attempts.

Meanwhile, an ad hoc technical committee appointed two weeks ago to review the flight test program (AW July 10, p. 24) has concluded that no design re-evaluation is necessary. The latest flight was the last development flight for the General Electric Mark 3 nose cone.

News Digest

Defense Department will establish a joint intelligence agency which will be staffed by the services and will be headed by an officer of three-star rank. Tactical and technical intelligence, however, will be left with the unified and specified commands and the three services.

USAF-Lockheed Midas III, experimental missile detection satellite, has been successfully launched into a polar orbit similar to the one planned for operational versions for the first time from the Naval Missile Facility, Pt. Arguello, Calif. The satellite was also the first in the series to use an Agena B second stage in the booster system.

Brig. Gen. Irving L. Branch will replace Maj. Gen. John W. Carpenter, III, this month as commander of Air Force Flight Test Center at Edwards AFB.

General Dynamics/Ft. Worth has a $12.95-million USAF contract for development, production and flight testing of a B-58 system that would carry four small nuclear weapons in addition to its large weapons-fuel pod (AW May 1, p. 27), increasing its total nuclear yield to 15 megatons.

Lockheed Georgia Division has a $1.2-million Army contract for research, development and flight test of two VTOL research aircraft, each powered by two Pratt & Whitney JT12 turbine engines, using the jet ejector lift principle. Lockheed has been working on this "Hummingbird" aircraft concept with its own funds for four years.

August Esenwein, former executive vice president of General Dynamics' Convair Division, will succeed Gen. Orval R. Cook, USAF (ret.) as president of the Aerospace Industries Assn. Dec. 31, when Gen. Cook retires. Esenwein will join AIA as deputy general manager Oct. 1.

Army-North American supersonic target missile, Redhead-Roadrunner, was successfully test-fired last week at White Sands Missile Range, N. M.

W. P. Thayer, vice president-general manager of Chance Vought Corp's Aeronautics Division, will be president of Chance Vought Corp. when it is established as a subsidiary of Ling Temco Vought, Inc., effective Aug. 31, Thayer will succeed Gifford K. Johnson, now president of Chance Vought, who will become president of Ling Temco Vought, Inc. Thayer will also be a member of LTV's board of directors.

Problems Loom for 'Visit USA' Program

Cost of touring America and lack of preparedness to accommodate visitors appear to be main obstacles.

By Glenn Garrison

New York—No tidal wave of foreign tourists visiting the United States is expected to result soon from new legislation putting the federal government in the business of promoting travel to this country.

The bill, passed by Congress and signed late last month by President Kennedy, establishes a new United States Travel Service within the Department of Commerce with a proposed initial budget of $5 million. It calls for the creation of U.S. travel offices abroad and for cooperation in the U.S. with various local and national segments of the tourist industry.

Airlines whose own "Visit USA" programs have expanded greatly in recent months see the government move as a long-needed basic step in the development of the vast and relatively untapped foreign tourism potential in the U.S.

But many obstacles remain to be overcome before this country can expect to attract a flow of tourists and tourist dollars to match the volume of U.S. tourist business overseas:

• **Cost of visiting** this country is a point of some controversy in the travel industry. One view is that Europeans, for example, with an increasingly high level of economy in many cases, can afford to tour the U.S. but have exaggerated ideas of prices here. This is a problem of education, it is held, so the European will become aware of low-cost motels and cafeterias instead of thinking of the Waldorf-Astoria. The other view is that costs really are beyond the reach of most Europeans. The cost of air transportation to the U.S. is an important element. One area of opinion holds that fares must be reduced to attract tourists here in great volume.

• **Preparedness of the U.S.** to handle foreign tourists en masse. It is held that this country is not geared for the foreign visitor; central information offices are lacking; the linguistic barrier is formidable; Americans are unaccustomed to accommodating foreign tourists and attitudes must be changed. These problems have been greatly overemphasized, U.S. airlines say.

• **Visa formalities** and other red tape discourage foreign residents from seeking admission to this country for a visit. Some progress in handling visas has been made, it is reported, and new executive and possibly legislative action may be taken in the future.

A major factor in the widespread "Visit USA" interest in the past couple of years has been concern with the imbalance of payments in U.S. trade and the gold flow out of this country. But airline officials stress that the program is more important for its own sake, both to develop the market potential and to promote international understanding through familiarization of many more people with the U.S.

Last year, according to recent Commerce Department figures, there was an excess of $1.1 billion in U.S. payments for foreign travel over U.S. receipts. Expenditures by Americans for foreign travel exceeded $2.6 billion for the year; foreign visitors to the U.S. spent $970 million.

The foreign visitors paid $110 million in transportation fares to U.S. shipping companies and airlines. U.S. visitors abroad spent more than $450 million with foreign ship lines and airlines.

Excluding those from Canada and Mexico, about 600,000 foreign visitors traveled in the U.S. last year. About 1,630,000 U.S. residents traveled in foreign countries.

With the new government program under way, a doubling of visitors to this country is expected within the next four years, according to Commerce estimates.

The stated purpose of the new legislation is "to strengthen the domestic and foreign commerce of the United States, and promote friendly understanding and appreciation of the United States by encouraging foreign visitors to the United States and by facilitating international travel generally." It was called "a major new effort to attract foreign visitors to the United States" by Chairman Warren G. Magnuson of the Senate Commerce Committee.

Advertising in overseas markets will be a major activity of the new service. While foreign governments spend about $10 million a year in the U.S. to promote travel to their countries—exclusive of much greater sums spent by their carriers—the U.S. has never made any major promotional effort in this direction.

Some officials of foreign flag airlines believe we will face a great challenge in tailoring our program to what will interest Europeans and other foreign residents. Our tourism, they say, is geared to U.S. tastes—and in large measure to automobile travel—and a whole new approach will be necessary.

As an illustration of what the foreign tourist may find lacking in a visit here, several carriers note that there is no U.S. hotel equivalent for the European concierge, who they consider an extremely valuable source of aid and information for the traveler out on the town.

However, the view that we are ill-equipped to handle volumes of tourists is not unanimous. Willis G. Lipscomb, vice president-traffic and sales of Pan American, stated otherwise during hearings on the recent legislation.

Lipscomb said "It has become almost fashionable to speculate over the shortcomings of the U.S. travel industry and to deprecate the ability of Americans to cater to the needs of the foreign traveler . . . we should not wait until all taxi drivers in Boise or Oklahoma City learn to speak French before the United States sets out to persuade Frenchmen to visit the United States." The goal of increasing the number of travelers twofold or threefold in the next few years should not place an undue strain on our tourist plant,

Tourist Exchange

Moscow—Six United States airline and travel representatives have been touring the Soviet Union looking into prospects of tourist exchange between Russia and the U. S. The group is returning a visit by a Soviet group to the U. S.

Intourist, the Soviet tourist agency, is trying to convince the U. S. group that Americans should launch a promotional campaign to attract Russian tourists, including advertisements in technical journals.

Travel to the Soviet Union by American tourists was down almost 40% last year. The drop is attributed to the American recession, the fact that the cream has been skimmed off the market so that Soviet travel is increasingly hard to sell and to the tense political situation.

Lipscomb said, and Americans' ability to play host will become more perfect as the demand increases.

While a mass market of foreign visitors is generally considered well in the future, airlines expect immediate increases particularly in group tour business. Package tours of the U.S. are being wholesaled abroad for the first time in quantity. The common interest tour has developed considerable business—professional or industrial groups attending conventions in their field or making special tours of facilities. Pan American, for example, handled 3,000 persons last year in this kind of activity.

The current interest in "Visit USA" has developed within the past two years, as foreign economies strengthened and the tourist imbalance increased. President Eisenhower proclaimed 1960 "Visit USA" year but no action was taken at the government level.

Airlines have been advertising for years, of course, to sell tickets to this country. But their efforts are necessarily competitive and the general advertising and promotion of the U.S. as a destination is a prime function the new tourist office can accomplish, as other countries have been doing for many years.

Expanded Efforts

Airlines' own efforts have expanded greatly in recent months. Some examples.

• **Pan American's accelerated** program calls for expenditure of $3.5 million this year to promote "Visit USA." Advertising, poster and local campaigns at 750 offices abroad will be used, and information folders widely disseminated.

• **TWA last year** opened its own travel information bureau in London and has expanded to three other European cities. More recently, TWA has been covering European cities with a "road show" of exhibits beamed at travel agents, local agencies and officials, and other segments of the industry. Buffets are served featuring American specialties. Another innovation is a "Visit USA" letter writing contest in which free transportation to and from the U.S. is offered. The airline has published an expanded American tour guide for travel agents, stressing low cost accommodations and packages. Brochures covering new packaged tours have been distributed to sales offices in Europe in three languages.

• **British Overseas Airways Corp.** recently completed its second special promotion by teams of officials visiting European cities with programs for travel agents, commercial representatives and diplomatic people. The teams hold receptions and make individual calls. Main reaction: there is a serious lack of information about the U.S. Needed: more and continuous promotion, more knowledge of this country, better facilities for tourism. BOAC also has published booklets promoting U.S. travel and listing package tour specialists, typical itineraries and also prices.

• **Scandinavian Airlines System** has held a series of workshops in Europe aimed at travel agency personnel. Domestic U.S. airlines, a bus company and hotel company were among those who participated with SAS in the program. A marketing program in Europe was launched in connection with the promotions. SAS believes a 300% increase in travel to the U.S. is possible in the next four years. The airline also has made suggestions for the improvement of reception facilities in the U.S.

• **Air France** is producing and distributing large quantities of brochures and manuals to travel agents and to the public covering U.S. travel. Specific tours are listed in conjunction with U.S. hotel and sightseeing companies. The travel agent material spells out how travel to the U.S. should be sold, how U.S. tours can be organized, reservations made, and so forth. The airline is convinced that strong educational efforts must be made in promoting U.S. travel.

The Commerce Department itself has warned that dramatic increases in U.S. tourism are unlikely to occur immediately when the new government program gets under way.

Brazilian Carriers Plan Merger; International Services Combined

Rio de Janeiro—Brazil's international carriers this month moved a step closer to formation of a single overseas flag carrier (AW May 15, p. 45) by agreeing to a consolidation of services.

Clearing the way for such a move, control of Panair do Brasil has passed from Pan American World Airways to a Brazilian group headed by Paulo Sampaio, former president of Panair.

The agreement involves Panair, Real, Varig, and Aerovias. The latter airline formerly was Real's international division, but recently, with a Varig purchase of half its voting stock, came under management of Real and Varig.

Airlines' Aims

In announcing the agreement, the airlines said it provided for "rationalization, complementation and fusion of services . . . in order to make possible, in the near future, formation of a single company, of private enterprise, to act as the instrument of Brazilian international aviation policy." A further aim was total re-equipment of Brazil's overseas services with jets needed "to conquer new markets, principally South American, African and Asian, to provide for round-the-world flights on Brazilian wings."

The agreement was made under government prodding and encouragement. It had its beginnings five months ago when the new economy-minded national administration of President Janio Quadros looked for means to save scarce foreign exchange and reduce costly subsidies. Quadros' interest is political as well as economic: he seeks to make Brazilian aviation a national instrument in his foreign policy of closer relations with Africa and Asia.

Among Brazilian aviation developments in the offing:

• **New law passed recently** by the senate stipulates that there be at least 80% ownership by Brazilian nationals of Brazilian airlines. This means Pan American will have to cut its Panair holdings from 30% to 20% and will probably liquidate completely if a suitable offer is received.

• **Panair's Middle East terminus** will be moved from Beirut to Cairo to satisfy Quadros' desire for closer ties to Egypt.

• **Panair will expand its routes** in Africa after signing of bilaterial accords between Brazil and Ghana and other new African nations.

• **Aerovias eventually** will fly up the West Coast of South America, and its routes will be extended from Tokyo to Red China or India, linking with Panair.

• **Panair, Varig, Real** (which keeps its own routes to Buenos Aires) and Aerovias will consolidate repair and maintenance facilities, sales, and interchange equipment. Aerovias expects delivery of Convair 990s this year. Real reportedly is negotiating with Lockheed for purchase of three Electras. Both Varig and Panair are in the market for jets for their domestic runs.

Sources in Brazil are speculating on whether the consolidation will result in sewing up of Brazil's future jet engine market for the British.

Rolls-Royce recently installed a jet engine repair facility in Sao Paulo. Varig's three Boeing 707-420s and two Sud Caravelles are equipped with Rolls-Royce powerplants.

Majority control of Panair was taken over by a Brazilian group headed by Sampaio, who left the Panair president's post in 1955. The group recently purchased 42% of Panair stock, increasing its holding to 62%. Price reportedly was about $1.1 million.

BULLETIN:

AeroShell Oil W becomes first fully compounded additive oil to win approval of every major aircraft piston engine manufacturer in the U.S.

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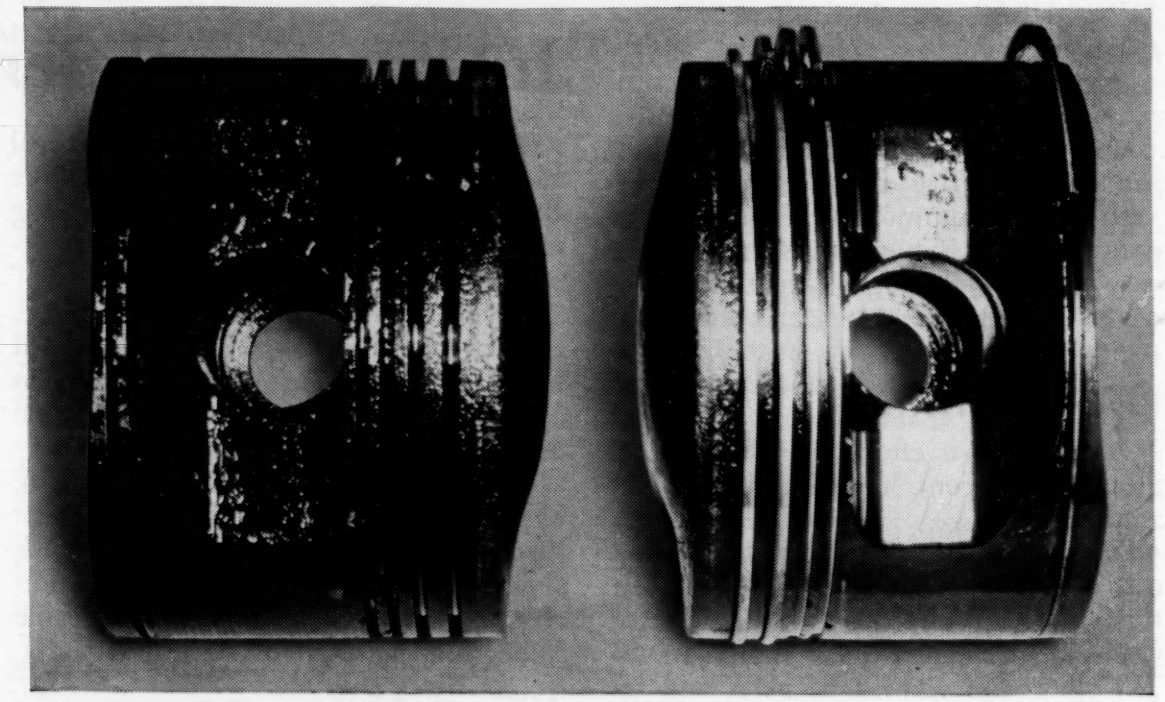

Left: Piston from engine using straight mineral oil after 1,000 hours; note sludge and coke. *Right:* Piston from same aircraft after 1,000 hours on AeroShell Oil W.

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Trunkline Traffic Slump Eased in June

By L. L. Doty

Washington—Domestic trunkline industry, hit by a severe traffic depression during the past seven months, experienced a slight improvement in June but most observers here feel that it is too early to determine whether the downward trend has been reversed.

Final figures from all domestic trunk lines had not been received late last week. However, an AVIATION WEEK estimate places the traffic increase for June at approximately 4% over the same month last year, hardly a substantial break from the steady traffic slump that began in May, 1960.

During the first six months of 1961, revenue passenger miles decreased 1.9% compared with the same period last year.

The first half of last year had shown a 7% increase over 1959.

In addition, the June increase is not sufficiently representative to indicate a new trend since actual comparative figures are clouded by a strike that curtailed operations of Eastern Air Lines for an 11-day period during June, 1960. Because traffic has remained sluggish during a period when the general economy appears to be recovering at a relatively stable rate from the recent recession, industry leaders are regarding the slump with alarm.

Revenue Rise

During the first five months of 1961, the trunkline industry will report a $19,670,000 net loss, compared with a $13,350,000 net loss for the first five months last year. Despite the traffic decline, operating revenues will show a 4.76% rise during this period.

Industry had no immediate explanation for the increase in revenues in the face of a traffic drop, although several officials felt that the rise in higher-yield long-haul traffic because of improved turbojet schedules, plus last year's boost in coach fares, may account for the contradiction.

Operating revenues climbed to $167,392,000 during the five month period, a 5.1% increase which accounts for the higher net loss. For May, the industry will report a net loss of $4.3 million, compared with $2.6 million in May, 1960.

Coach traffic continued to show an increase while first-class traffic followed the downward trend which began a year ago. The Big Four—American, Eastern, United and TWA—experienced a 5.9% increase in revenue passenger miles in June, but first-class traffic fell 13.5% while coach traffic rose 25%.

Merger Factor

The Big Four results are not indicative of a trend since Capital Airlines' traffic was absorbed by United Air Lines in June as a result of the merger between the two companies. United carried a total of 1,159,300 passengers last month, which the airline claims is a monthly record. The carrier operated 791.2 million revenue passenger miles during June.

There is now no doubt that United will dominate the industry in the volume of passengers handled. Even before the merger, United had taken first place within the domestic industry in the number of revenue passenger miles moved. The airline, an original opponent of high-density coach seating, moved into first place in March, compared with third place the previous March, in the amount of coach revenue passenger miles handled.

Among the domestic trunklines, American remained the leading carrier in the cargo field, an area that has attracted new attention as passenger traffic continued to drop. American's 11,377,000 ton miles, which it claims is an industry record, represented a 24% increase over the same month of 1960 and topped United's June cargo business by 1.4 million ton miles.

Summer Decline

Industry first began watching the declining passenger volume seriously in mid-summer of 1960. In March, 1960, revenue passenger miles fell 1%, the first time a drop had occurred since the bad-weather month of January, 1959.

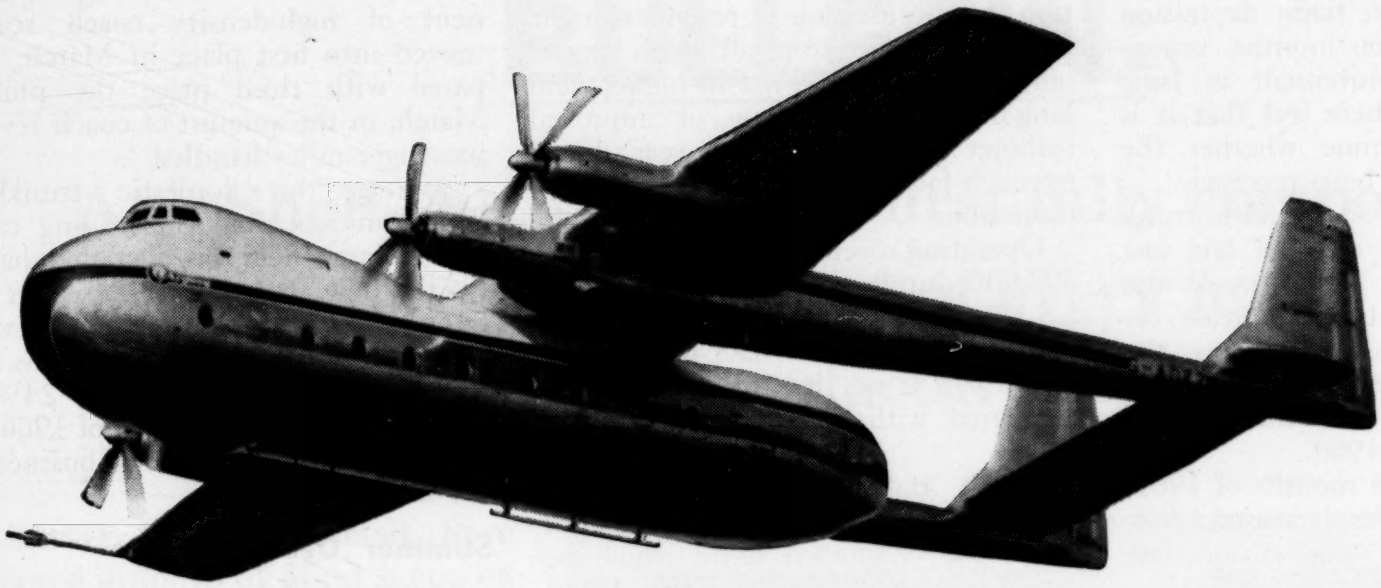
However, business rebounded in April, 1960, with an 11% increase, and the March decline was attributed to poor weather in high-density market areas. During the next six months, traffic leveled-off to slight increases of an approximate average of 3%, compared with healthy monthly increases of some 15% throughout 1959.

The drop in the historic growth pattern was attributed to last year's recession.

The steady decline in traffic began in November, 1960, when the industry registered a 3.2% dip in revenue passenger miles. In December, the decline

Eastern 720 Transport Rolls Out of Boeing Plant

First of 15 Boeing 720 medium/long-range turbojet transports scheduled for Eastern Air Lines is rolled out of Boeing Co.'s Renton, Wash., facility. Eastern will receive 12 of the aircraft before the end of the year and the three-plane balance in 1962. Eastern plans to place three of the Pratt & Whitney J57-powered planes in service this fall.



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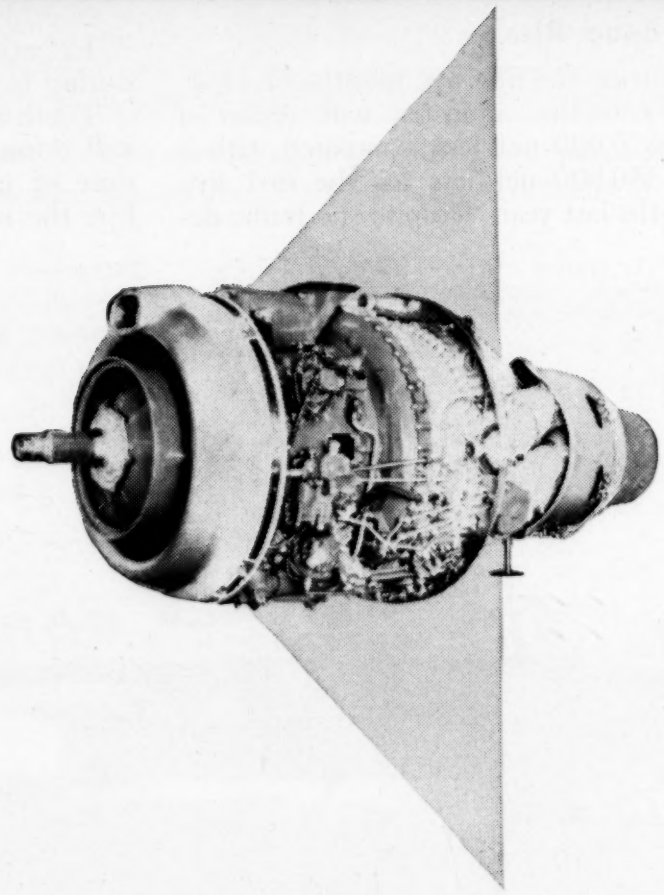

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Viasa Receives First 880-M for South America

First Convair 880-M takes off from Lindbergh Field in San Diego after acceptance by Viasa, Venezuelan national airline. Viasa crews have completed ground training and will undergo flight training in the plane during July. Viasa will begin New York-Caracas service in August. Other cities to be served include Miami, New Orleans, Bogota and Lima.

was 4%, and it was 2.7% in January and 14.9% in February. Operations were suspended from February 17 to 23 by American, Eastern, National, TWA and United due to strikes.

In March, the industry found some hope in a 5% rise in revenue passenger miles, although neither Northwest nor Western had returned to full operations following the labor problems.

In April, the downward trend returned and the industry suffered a 1.8% drop in revenue passenger miles. There was no improvement in May, when a 2.6% decline was reported, despite the fact that all airlines had returned to normal operations.

A number of industry officials are reemphasizing their positions that excessive carrier competition on major routes is causing serious financial damage to individual carriers because capacity is completely out of line with the traffic available. At the same time, each carrier is intensifying sales and promotional campaigns to lure available traffic away from its competitors.

The Civil Aeronautics Board has publicly announced that it will watch the competitive picture closely, and it is highly possible that the forthcoming Northeast Airlines New York-Florida route renewal case may prove a test of how far the Board will go in recommending mergers or taking steps to consolidate routes to correct the competitive problem. However, CAB Chairman Alan S. Boyd has indicated that he will insist that airline managements take immediate steps to explore new means of opening new markets.

A large-scale, industry-wide marketing program may be in the making as a result of the current airline depression.

KLM Talks Collapse

Washington—Talks between the U. S. and The Netherlands on amendments to a bilateral air transport agreement collapsed last week when the Dutch refused to concede to U. S. demands that traffic on the North Atlantic route be restricted.

The Netherlands government has been seeking traffic rights into Los Angeles. The U. S. was willing to grant the route for KLM only if the Dutch agreed to restrict future increases in the number of passengers they now carry on the North Atlantic route (AW Apr. 24, p. 38). The U. S. has held that the Dutch are already in violation of the bilateral agreement between the two countries by offering an excessive volume of seats on the route.

The Dutch have argued that the capacity now available is in line with traffic demand but they were unable to demonstrate that any substantial amount of the traffic between the West Coast and Europe originated in or was destined for Holland. The Dutch delegation has returned to The Hague with no date set for resumption of the talks.

U.S., Soviets to Begin Bilateral Negotiations

Washington—U. S. and Russia will begin negotiations July 18 on a bilateral air transport agreement for reciprocal air routes between Moscow and New York.

James M. Landis, special assistant to the President, will be chairman of the U. S. delegation, and Edward Bolster, director of the State Department Office of Transport and Communications, will be vice chairman. As chairman of the Civil Aeronautics Board beginning in 1946, Landis participated in negotiation of a number of bilateral agreements between the U. S. and other nations.

Col. Gen. Yevgeni F. Loginov, chief of Aeroflot, will be chairman of the Soviet group. Pan American World Airways, certificated to operate the route, will be represented in observer status on the U. S. delegation.

Originally, talks were scheduled for July 18 last year but were called off by the State Department on July 14 after Russia shot down an RB-47 in the Barents Sea on July 11.

United Air Lines DC-8 Crashes at Denver

United Air Lines Douglas DC-8 turbojet transport crashed at Denver's Stapleton Field last week during an emergency landing, killing 18 of the 120 persons aboard.

Surviving passengers said they were told about 10 min. before landing that the aircraft's hydraulic system was not functioning properly. The pilot, Capt. John F. Grosso, radioed Denver that the supply of hydraulic fluid appeared to be low but later reported it was adequate. The DC-8 apparently landed hard, spun off the runway, hit a survey truck parked at the edge of the airport and burst into flames as it stopped.

Civil Aeronautics Board immediately organized a six-group panel to launch its investigation. Panel is headed by Melvin Gough, director of the Board's Bureau of Safety and will include representatives from CAB, Federal Aviation Agency, United Air Lines and Douglas Aircraft Co., Inc.

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East German Il-18 Flight Costs Run High

Geneva—Soviet-built equipment supplied to East German Lufthansa has touched off heavy operational losses, according to an East German airport manager who has fled to the West.

Flight hour costs and purchase price for replacement engines have far exceeded estimates, he said, and periods between major overhauls have dropped well below original Soviet recommendations.

East German Lufthansa's three Il-18 turboprop transports used over most of the airline's international routes cost approximately $4,500 per flight hour as compared with a maximum of $1,500 actual revenue for every hour flown with a full passenger payload, according to Emil Frost, former manager of East German Lufthansa's Barth airport near Stralsund in Mecklenburg, about 115 mi. from Berlin.

Major Overhauls

Frost says the Il-18's four Ivchenko 4,000-shp. engines require a major overhaul after only 200 flight hr. and that the current replacement cost per engine is around $137,500. Last winter, as Ghana Airways prepared to take delivery of the first of six Il-18s on order, its officials said major overhauls after 500 hr. and complete scrapping of the Ivchenko engines after a total of 2,000 hr. had been recommended by the Russians (AW Dec. 12, p. 38). Purchase price per engine had been quoted to them as approximately $92,400, almost 50% less than that East German Lufthansa has found it needs to pay.

Frost said conditions are just as uneconomical with regard to the airline's Soviet-built Il-14s, which represent the backbone of its operations. Cost to the carrier per flight hour is $575 as compared with a potential maximum revenue of $185 for every hour flown. He said, however, that the Il-14s are usually fully booked.

According to other West Berlin sources, Scandinavian Airlines System offered to sell several Douglas DC-6s to East German Lufthansa at a favorable price in the summer of 1958. Arthur Pieck, former chief of the East German carrier and now deputy minister of transport in East Berlin, rejected the offer on the grounds that, politically, East Germany did not wish to buy aircraft from capitalist firms.

Following the pattern of the Soviet carrier, Aeroflot, CSA Czechoslovakian Airlines and the state-owned airlines of most East European countries, the operation of East German Lufthansa, headquartered at Schonefeld airport in East Berlin, is divided into two categories—commercial aviation in the Western sense plus the additional responsibility for general utility operations. The second category, encompassing a fleet of multi-purpose aircraft, devotes about 80% of its effort to agricultural duties, the remaining 20% to advertising, charter flights, air mapping purposes, etc. West German sources report that on occasion they also are requisitioned for flights designed to aid victims of whooping cough and other respiratory diseases.

The fleet operated by the commercial aviation department is composed of about 30 Il-14s, 3 Il-18s and six 8-to-9-seat An-2 aircraft. The An-2s are used for sightseeing flights and on the carrier's domestic route between East Berlin and Karl-Marx-Stadt (formerly Chemnitz).

Most important international service, according to East German Lufthansa officials, is the airline's 84-seat Il-18 once-a-day round trip between East Berlin and Moscow, which it operates in pool with Aeroflot, the Soviet state-owned airline. Twice a day round-trip 89-seat Il-18 flights also serve Bucharest, Sofia and Tirane out of East Berlin. On May 28 this year, three daily Il-14 flights began services to Hungary, Rumania and Bulgaria and on a once-a-day basis to Yugoslavia, Albania and Greece. Il-14 charter flights are available as well on many of these routes, but demand for these, according to East German Lufthansa representatives, is greater to the Black Sea area, particularly during the summer months.

East German Lufthansa and its associated charter company, Interflug GmbH., jointly operate regular scheduled pool services with five foreign carriers: CSA, LOT, MALEV (Hungary), TABSO (Bulgaria) and TAROM (Rumania) from East Berlin to Budapest, Sofia, Bucharest and Belgrade. According to passenger demand, Il-14s with either 28- or 32-seat configurations are used on these flights.

In addition, freight services with converted Il-14s are run from East Berlin to Prague, Bucharest and Sofia with the return flight stopping only at Budapest.

East German Lufthansa's utility operations use a fleet of 60 Czech-built multi-purpose Brigadyr L-60s, nine An-2s and two Russian Mi-4 general-purpose helicopters, according to West Berlin sources.

The East German government's Seven-Year Plan calls for this utility operations section to increase its fleet to a total of about 170 aircraft by 1965. It also stipulates that East German Lufthansa shall increase its ton-miles of freight and mail carried to 7,672,000 ton-mi. during the same period compared with 890,500 ton-mi. in 1958, the last figure available. In 1959, a total of 168,000 passengers were carried on the airline's domestic network. Total tourist-class passengers transported on the carrier's international routes numbered 37,000 last year.

Airline's S-62 Overturns in Water

Sikorsky S-62 helicopter of San Francisco & Oakland Helicopter Airlines was damaged slightly when overturned recently by high winds after a successful autorotative landing about 300 yd. off shore in San Francisco Bay.

The helicopter's pilot had made a precautionary landing because its General Electric CT-58-100 turbine engine began to overheat about 2 min. after taking off empty from San Francisco International Airport bound for the downtown San Francisco heliport to pick up passengers. The landing was good and the helicopter appeared to be riding well on its hull and pontoons. However, a high swell was running and winds were gusting to 38 mph.

Shortly after the landing, a gust caught the helicopter and flipped it on its side. It did not sink and was towed ashore successfully. The pilot was not injured. The rotor was damaged during the tow but this was the only apparent injury suffered by the aircraft aside from salt water corrosion. San Francisco & Oakland president M. F. Bagan said it is likely that the airline will equip its helicopters with sea anchors to prevent heavy water damage in any future open-water landings. Sikorsky engineers are recommending that other S-62 operators take similar precautions.

Cause of the engine overheating has not yet been determined by General Electric investigators, who returned the engine to GE's Lynn, Mass., Small Aircraft Engine Dept. Bagan told AVIATION WEEK that both Sikorsky and General Electric had approved the airline's operating procedures.

The helicopter is now being studied to learn the extent of salt water penetration in seams and other critical places. It will be grounded for a few weeks while steps are taken to halt and repair corrosion. Sikorsky aircraft has loaned the airline another S-62 to maintain schedules during this period.

San Francisco & Oakland is a non-subsidized airline and has just completed its first month of operations (AW June 26, p. 42). It operates two 10-passenger S-62s.

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Halaby Refuses to Restrict Southern

By David H. Hoffman

Washington — Federal Aviation Agency Administrator N. E. Halaby, guided by an agency investigation of 250 alleged flying violations filed against Southern Airways, has rejected suggestions that the carrier's operating authority be restricted.

Halaby's stand drew immediate criticism from Air Line Pilots Assn. officials who last week accused the administrator of "foot-draging" and staging a "whitewash." Concurrently, a group of senators and congressmen concerned with the 14-month-old pilot strike against Southern were debating whether to press Halaby for confidential FAA reports stemming from the recent investigation.

Critics of Halaby's handling of complaints against non-union Southern pilots generally contend that FAA's investigation report to congressmen contains a significant contradiction. They feel that especially in view of Southern's reliance on federal subsidy, the number and seriousness of the violations actually uncovered underscores a need for more drastic action than suspended pilot's licenses and fines.

ALPA spokesmen supporting this view cite Civil Aeronautics Administration's crackdown on Northeast Airlines in 1958 (AW Oct. 27, 1958, p. 38). After air carrier inspectors found that some Northeast pilots were having difficulty passing instrument checks CAA ordered all the airline's captains restricted to visual flight rule operation until personally examined in flight by agency check pilots. Despite Southern's safety record—no major accidents since the strike—ALPA maintains that comparable precautions should be taken.

Three Alternatives

Renewed legislative interest in the Southern strike could produce one of three results. From the union standpoint, the most desirable would be the appointment of a presidential commission to investigate ALPA's accusation that Southern has taken an unreasonable position in refusing arbitration, along with the flying safety violation charges. A second possibility now being studied is an independent investigation of the Southern situation by at least one congressional committee.

A third alternative that could result from legislative pressure is a Justice Department inquiry into whether Southern violated Section 610 of the Aviation Act of 1958 by hiring unqualified airmen.

In a July 6 letter to a group of interested legislators—including Senators A. S. Mike Monroney (D.-Okla.), Warren Magnuson (D.-Wash.) and Estes Kefauver (D.-Tenn.) and Rep. Joe Evins (D.-Tenn.)—Halaby summarized a background investigation of non-union pilots employed by Southern since the strike began June 5, 1960. The administrator disclosed that:

- **Psychiatric treatment** was received by three pilots "presently employed" by Southern. An emergency FAA license suspension immediately grounded these three. Examination by an FAA staff psychiatrist subsequently gave one "a clean bill of health," according to Halaby. The other two were sent through a series of tests at Emory University, Atlanta, Ga., on June 27, the results of which will be analyzed by FAA.
- **"Behavioral abnormalities"** displayed by one pilot no longer with Southern once led to his hospitalization. Pending re-examination, this pilot also has been grounded. Another pilot (AW June 12, p. 41), who flew as captain in command of Southern Douglas DC-3s while holding only a private pilot's license, had his certificate revoked by FAA. His case will be referred to the Justice Department if FAA uncovers evidence of forgery.
- **FAA, for the first time** in its history, revoked a sixth pilot's Airline Transport Rating and his current medical certificate after learning that the pilot had served two prison sentences, undertaken several bigamous marriages and earned a "general reputation for instability and abnormal conduct," Halaby said.

But all of these pilots, Halaby observed, were found by FAA inspectors to have the "flight qualifications" required of captains.

Of approximately 250 allegations filed by ALPA accusing non-union Southern pilots of violating the Civil Air Regulations, Halaby said that "well over 200" were aimed at pilots who reportedly exceeded maximum flight time limitations. After a thorough investigation of each complaint, one such violation was uncovered by FAA, a violation termed "minor and unintentional" by Halaby.

Turning to the alleged violation of other CARs, Halaby said that in eight instances the discrepancy was of sufficient magnitude to warrant either action against the airman's license or a civil penalty. These included the operation of a DC-3 in scheduled service with its landing gear down and locked in place with safety pins, the landing of a DC-3 at the wrong airport, a departure from Nashville Airport without a takeoff clearance, three instrument approaches or landings in below-minimum weather and one instance in which a pilot elected to land on his destination airport's shortest runway, then ground looped his aircraft to avoid a ditch at the runway's end.

Halaby concluded his report to the legislators by expressing doubt that Southern "exercised sufficient vigilance and judgment in the early stages of its pilot replacement program" in the screening of applicants. "This subject," he said, "remains under consideration by this agency pending completion of our inquiry."

But Halaby also reported that Southern apparently was complying with appropriate regulations and that "no action against the certificate of Southern is required in the public interest."

It appeared certain last week that at least one congressman, Rep. Robert W. Hemphill (D.-S. C.), would ask Halaby to furnish the raw material from which the Southern investigation report was composed. However, Rep. Hemphill, a World War II bomber pilot, made it clear that he would reserve judgment on the adequacy of the FAA investigation until this information had been received and digested.

ALPA is convinced that it cannot afford to accept the status quo at Southern without severely weakening itself as a union. It is aware that the success of Southern management serves as a constant reminder to other airlines that ALPA is not invincible and that such awareness could lead to tougher bargaining in the future.

At the same time, ALPA is concerned that the International Brother-

Czech Il-18 Crashes

Geneva—Czechoslovak Airlines lost its second Soviet Il-18 transport in the past three and one-half months last week when one of its turboprop airliners struck a high-tension line on a low, bad-weather approach to an airfield near Casablanca, Morocco.

The crash, which cost the lives of all 73 persons aboard, apparently had no connection with the loss of a CSA Il-18 over Germany on Mar. 28 or the grounding of the aircraft for several months last summer (AW Aug. 29, p. 45).

CSA officials in Prague said the plane was on a routine once-a-week flight from Prague to Rabat, Dakar, Conakry and Bamako via Zurich. Diverted from Rabat to Casablanca by fog, the aircraft also found Casablanca weathered in and was told to land at an auxiliary field about 10 mi. away. During its approach, it struck the high-tension wire and apparently exploded.

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hood of Teamsters could gain its first foothold among airline pilots by organizing the non-union employes at Southern.

Meanwhile, Southern reports that in June it carried a total of 36,639 passengers, a record for any month's operation.

This represented an 8% increase over the airline's May business, when Southern boarded 33,884 passengers. With the addition of Morristown, Tenn., and Pascagoula, Miss., on July 1, Southern now serves 61 cities in ten southeastern states.

Strike Forces BOAC To Charter Aircraft

London—Unofficial strike by about 400 British Overseas Airways Corp. employes at London Airport last week forced the airline to charter equipment for transatlantic passenger connections at Prestwick, Scotland.

The strike involves electricians in the Bristol Britannia hangar, about 100 men from the de Havilland Comet instrument shop and others from propeller and thrust reversal repair shops. At issue is a new BOAC supervisory system, in which foreman and inspector jobs have been merged into a single supervisory job.

BOAC chartered two Viscounts, one from British United Airways and the other from Tradair, and a Britannia from Cunard Eagle Airways, with whom it will be competing on the North Atlantic next year.

About 200 passengers were transferred to Prestwick, Scotland, to meet connecting flights to New York, Caracas and Montreal.

As of mid-week, three Britannia flights had been canceled because of the strike, one outbound to Bengazi and two inbound from Montreal.

The company said the supervisory system is the last phase of a planned reorganization of the engineering department to reduce costs. In a letter to strikers, Charles Abell, chief engineer, cited a drop in BOAC business and a rise of competition, asking:

"Is this the time to damage BOAC when we are preparing our appeal against the Air Transport Licensing Board's decision to license another operator on the North Atlantic?"

Meanwhile, BOAC has completed X-rays of its 31 Britannias, finding five airplanes with cracks in the elevator hinge bracket (AW July 10, p. 36). Bristol Aircraft, the manufacturer, said X-ray of the component is mandatory for all operators, including Royal Air Force and Royal Canadian Air Force. The fix is part replacement, but the company said a design modification may be made.

U.S. Recession Called Main Cause For Slump in Transatlantic Traffic

New York—U.S. recession has been the single major cause of the slump in transatlantic airline traffic, in the opinion of KLM's new 43-year-old president.

E. H. van der Beugel, who took the top KLM post June 1, said the slump was an unexpected problem for the carriers in a year when all their problems had been concentrated by the technical and financial difficulties of transition to jet aircraft. Whereas they had planned for normal North Atlantic growth, traffic not only has not materialized in the last month but has actually declined, "which worries us very much."

But, barring a grave political crisis over Berlin, the trend should change very shortly and long-range prospects are good, van der Beugel said last week at a conference here.

The KLM official discounted other theories as to the reasons for the slump, such as general political unrest and publicity concerning the U.S. balance of payments. He said the recession thesis is confirmed by the U.S. domestic traffic decline, which he said almost exactly parallels the transatlantic traffic trend.

KLM's own prospects for 1961 are unsatisfactory from a financial viewpoint, van der Beugel said. Revaluation of the Dutch guilder this year was a severe financial blow to the airline, resulting in an approximate 5% loss of revenue (AW May 29, p. 42).

The new KLM president, who in 1957 as The Netherlands' deputy minister of foreign affairs headed the Dutch delegation that negotiated their first bilateral agreement with the U.S., would not comment on recent attacks by Pam Am and TWA. Negotiations now are going on in Washington, he pointed out. But he said it was ironical that aviation, the most modern of commercial transportation enterprises, should be bound by bilateral procedures in a world that since 1946 has grown to multilateral dealings in most fields of economic activity.

Regarding the "Visit USA" programs currently receiving considerable attention, van der Beugel said attracting European tourists to this country is a top priority activity of KLM for the next few years. It is self-evident, he said, that with the increase in Europe's standard of living there will be a vast increase in tourism to the U.S.

Holland ranks fourth, he said, in numbers of European visitors to this country despite its 12 million population, and KLM has been a leader in the field of promoting such traffic in Europe.

But there are "a few difficulties" in the "Visit USA" efforts. This is still a very expensive country for Europeans, van der Beugel said. Another problem is what to do with the tourist beyond New York. Visa formalities have been a significant obstacle in the past, but there has been a definite improvement in the past six months. In general, the U.S. is among the friendliest countries in dealing with visitors, "but people haven't the faintest idea of what to do with tourists."

Other points touched on by the KLM president:

- **The 17-day off season** excursion fare has diverted passengers from first class, but its purpose was not to boost first class but over-all traffic and this has been accomplished.
- **Transatlantic breakeven** load factor of KLM's Douglas DC-8 airliners is about 50%.
- **Freight gross volume** will have to increase 20% next September, when new lower rates go into effect on the Atlantic, to keep revenues at their present level.

Engineers Will Fly Berlin Runs in Strike

Washington—Flight Engineers International Assn. told President Kennedy last week that its members would continue to work on Pan American World Airways aircraft flying to Berlin if the union should strike on the airline's other services.

FEIA is deadlocked with Pan American in a dispute over recommendations made by the Feinsinger Commission last May that the union merge with Air Line Pilots Assn. and that turbojet crews be limited to three men, all pilot trained (AW July 3, p. 38). Deadline for the final "cooling off" period is July 19.

Pan American operates 20-30 flights a day into Berlin from Frankfurt and Hamburg, mostly carrying light cargo as part of the Inter-German Service Agreement.

FEIA sought to assure the President that national security in Berlin would not be endangered in the event of a strike.

In another labor development, Western Air Lines mechanics voted 260-248 to withdraw from the International Assn. of Machinists and to join the Teamsters.

AIRLINE OBSERVER

► Department of Commerce study group is taking a broad look at national transportation goals. Results of this study, which will take advantage of Projects Horizon and Beacon research, will be forwarded to Commerce Secretary Luther Hodges who intends to implement a Hoover Commission recommendation calling for a coherent U. S. transportation policy. The four-man task force, organized by Wilfred Owen of Brookings Institution, is coordinating aviation aspects of the Commerce study with Federal Aviation Agency Administrator N. E. Halaby.

► **Sud Aviation is seeking government approval to increase its Caravelle production program to 250 aircraft. Presently, the Caravelle program is based on a total production of 150 aircraft which, with firm orders of 118 plus 28 options, is about completed. Sud officials say that 250 aircraft represent a reasonable estimate of Caravelle market possibilities. Breakeven point is 225.**

► Allegheny Airlines is taking final steps to dispose of its fleet of eight Douglas DC-3s. The airline will operate all its services with a fleet of 29 aircraft including five Convair 540 turboprop transports, eight Convair 440 Metropolitans and 16 Martin 202 and 202A transports. Earlier this month, Allegheny purchased four Martin 202As from TWA.

► **Armstrong Whitworth will send a team to the U. S. to conduct modifications on Argosy turboprop cargo transports delivered to Riddle Airlines. Modifications are to correct skin cracks caused by aerodynamically induced vibration at the fin-tailplane junction. Carrier has three planes delivered and will receive remaining four, which have been fully modified, this month and in August. Two of the aircraft are in Logair operations at an average of 10 hr. utilization. By September, Riddle plans a 13-hr. utilization for each aircraft on Logair to meet contract schedules.**

► Clarence N. Sayen, president of Air Line Pilots Assn., was scheduled to leave last week for a one to two week stay in the Soviet Union despite policy drafted by the AFL-CIO executive council which discourages such trips by U. S. union leaders. Sayen was going as the guest of the Soviet civil pilots organization in his capacity as president of the International Federation of Air Line Pilots Associations. ALPA's own executive committee was not consulted.

► **Resort Airlines is seeking Civil Aeronautics Board approval to sell three Douglas DC-4s and 15 Pratt & Whitney R-2000 engines to British United Airways. Planes are to be delivered no later than July 31.**

► Continental Airlines and TWA have been granted a 2,000-hr. time between overhaul period by the Federal Aviation Agency for the Pratt & Whitney JT3C turbojet engine which powers the two carriers' Boeing 707 fleets. It is the first time a U. S. designed and manufactured turbojet has reached the 2,000-hr. standard for overhauls.

► **Local service airline industry will report record traffic gains in June.**

► Russia's East European satellites are still going to absurd lengths to withhold meaningful data on commercial airline traffic. During Rumania's recent Aviation Day, marking the 51st anniversary of the first flight by a Rumanian pilot, the government guardedly revealed that "during the first five months of 1961 the volume of air traffic was 7.5 times greater than in all of 1938."

► **Fairly heavy selling of Eastern Air Lines stock by officers during April and May doesn't necessarily reflect their attitudes on the company's outlook. Many Eastern officers borrowed extensively from banks when Eastern's stock option plan went into effect, and these loans fell due at a time when the stock price had fallen.**

SHORTLINES

► **Eastern Air Lines** will build a $3.7-million hangar and maintenance facility at Atlanta Airport, to be completed by fall, 1962. The hangar will house three Boeing 727-size aircraft or two 727s and one larger transport, such as a Douglas DC-8.

► **East Coast Flying Service** has been awarded an $813,325 Military Air Transport Service contract to haul passengers and cargo in the southeastern U. S. for National Aeronautics and Space Administration.

► **Federal Aviation Agency** has awarded the Raytheon Co. an $11.6-million contract for 40 radar bright display systems to be installed in FAA air route traffic control centers.

► **International Air Transport Assn.** reports two African airlines—Air Guinee, of Republic of Guinea and Air Mali, Republic of Mali—and an Argentine carrier—Trans Atlantica Argentina—are new members.

► **New York Airways** reports one of its Boeing-Vertol 44 helicopters has flown more than 5,000 hr. during the last three years.

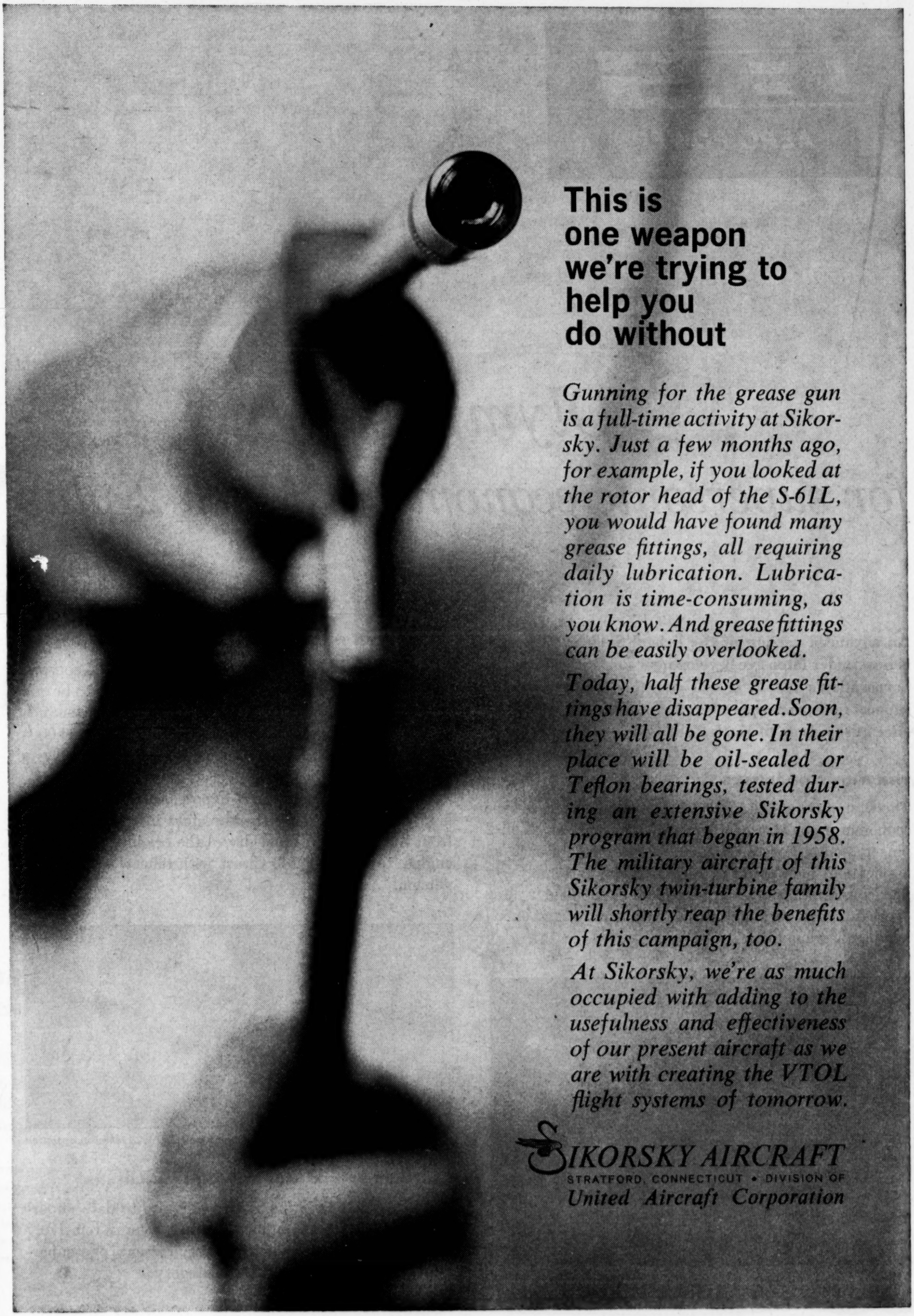
► **Pacific Air Lines** will offer $1.8 million 6.5% convertible subordinated debentures and 180,000 shares of common stock for sale in August. The proceeds will be used primarily to pay debts incurred from buying new aircraft and engines.

► **Sabena Belgian Airlines** has ordered two more Sud Mark VI Caravelle jet transports, bringing its order to a total of eight.

► **San Francisco & Oakland** Helicopter Airlines reports it carried 331 revenue passengers on June 30, one month after it began operations in the San Francisco Bay area.

► **Systems Analysis and Research Corp.** has been organized by two former members of United Research Corp.: Nathan S. Simat, president of the new organization, and Sam I. Aldock, vice president. Chris E. Steier, former research analyst for the Air Transport Assn., also has joined the company.

► **Trans World Airlines** will begin showing movies July 19 in the first-class section of aircraft on transcontinental flights. Inflight movies will be shown on transatlantic and West Coast-Europe polar flights after Aug. 16.



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Gunning for the grease gun is a full-time activity at Sikorsky. Just a few months ago, for example, if you looked at the rotor head of the S-61L, you would have found many grease fittings, all requiring daily lubrication. Lubrication is time-consuming, as you know. And grease fittings can be easily overlooked.

Today, half these grease fittings have disappeared. Soon, they will all be gone. In their place will be oil-sealed or Teflon bearings, tested during an extensive Sikorsky program that began in 1958. The military aircraft of this Sikorsky twin-turbine family will shortly reap the benefits of this campaign, too.

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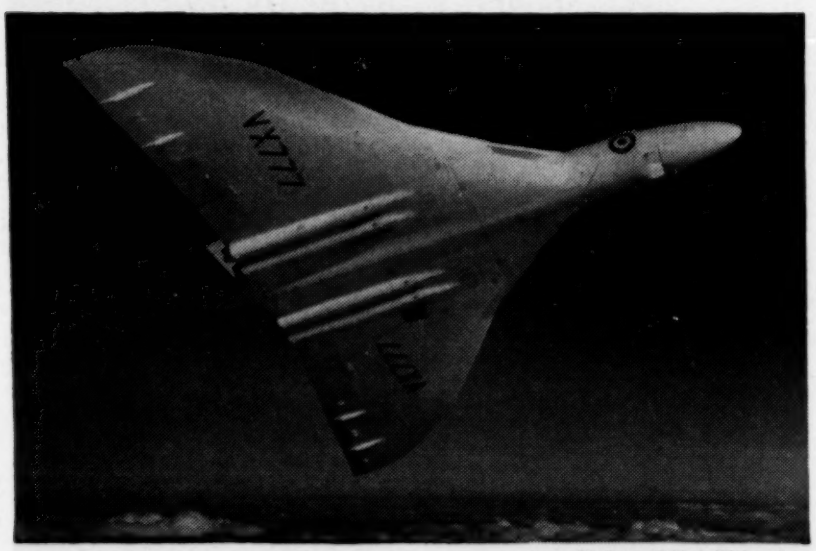

Avro Vulcan Mk 2 V-bomber

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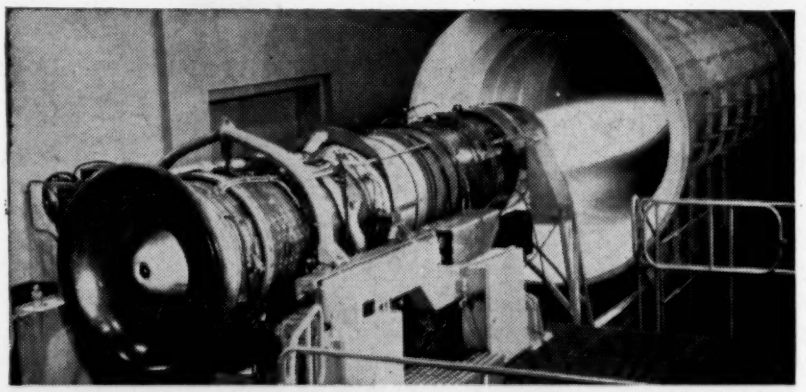
The Olympus has proved itself in several years' service, as the powerplant of the Avro Vulcan V-bomber, to be one of the most successful turbojets ever built. Maintenance is exceptionally low—last year, for example, on a 26,000-mile, round-the-world tour, the maintenance required was negligible.

The truly astonishing built-in potential of the Olympus has been confirmed by the threefold increase in power from the 11,000-lb thrust dry of the original production engine, to the 33,000-lb thrust with reheat of the latest version.



Olympus under test with reheat in operation

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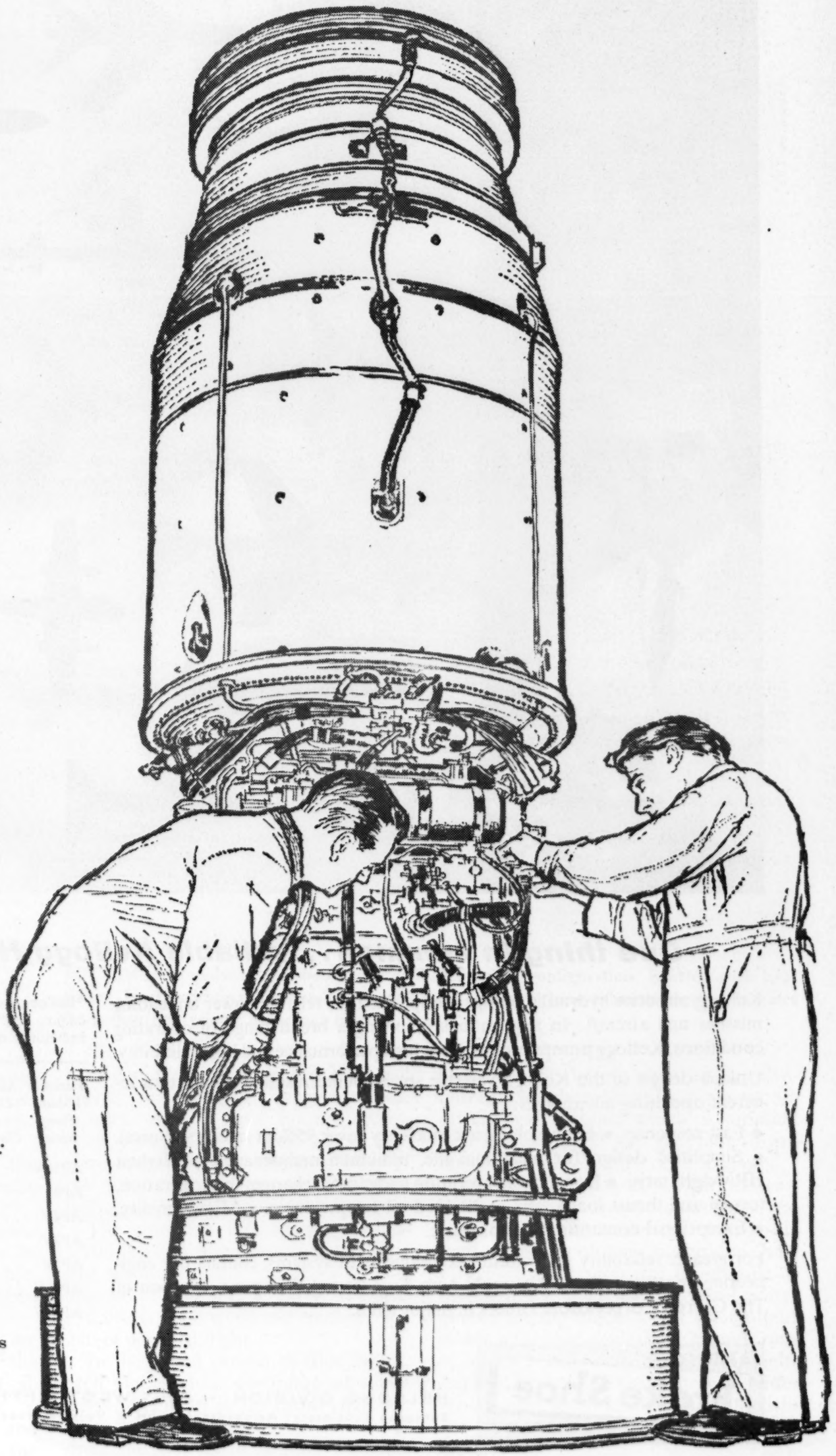
Already selected for the RAF's most up-to-date supersonic aircraft, the Olympus will clearly require relatively minor changes to adapt it to the requirements of a supersonic airliner in the same speed category.



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Thrust of Blue Streak Engine Increased

By Herbert J. Coleman

London—Rolls-Royce RZ.2 rocket engine for de Havilland Blue Streak launch vehicle has reached thrust velocities of 150,000 lb. and this can be increased 10% with relatively minor modifications, a Rolls-Royce engineer said here.

A. V. Cleaver, Rolls' chief rocket engineer, told the European Symposium on Space Technology that tests have shown the RZ.2 engine can run stably down to about 50% thrust and could achieve lower levels through modification of the thrust chamber injection system.

If required, Cleaver said, a throttled version of the engine, which would provide controlled thrust, could be built. At present, running reliability is 96%, and starting reliability is 92%. In testing the RZ.2 in paired configuration (designated RZ.12), starting reliability has been 95% and running has been 100%. Better performance was due to smaller sampling and more reliable engines as the program progressed.

There have been 48 tests of the paired engines, compared with 317 for the single RZ.2. Starting has been a major problem. For instance, out of 474 starting attempts on the RZ.2 only 365 were successful. A great number of these failures, Cleaver said, were due to problems in the test system, especially in the early days of operation.

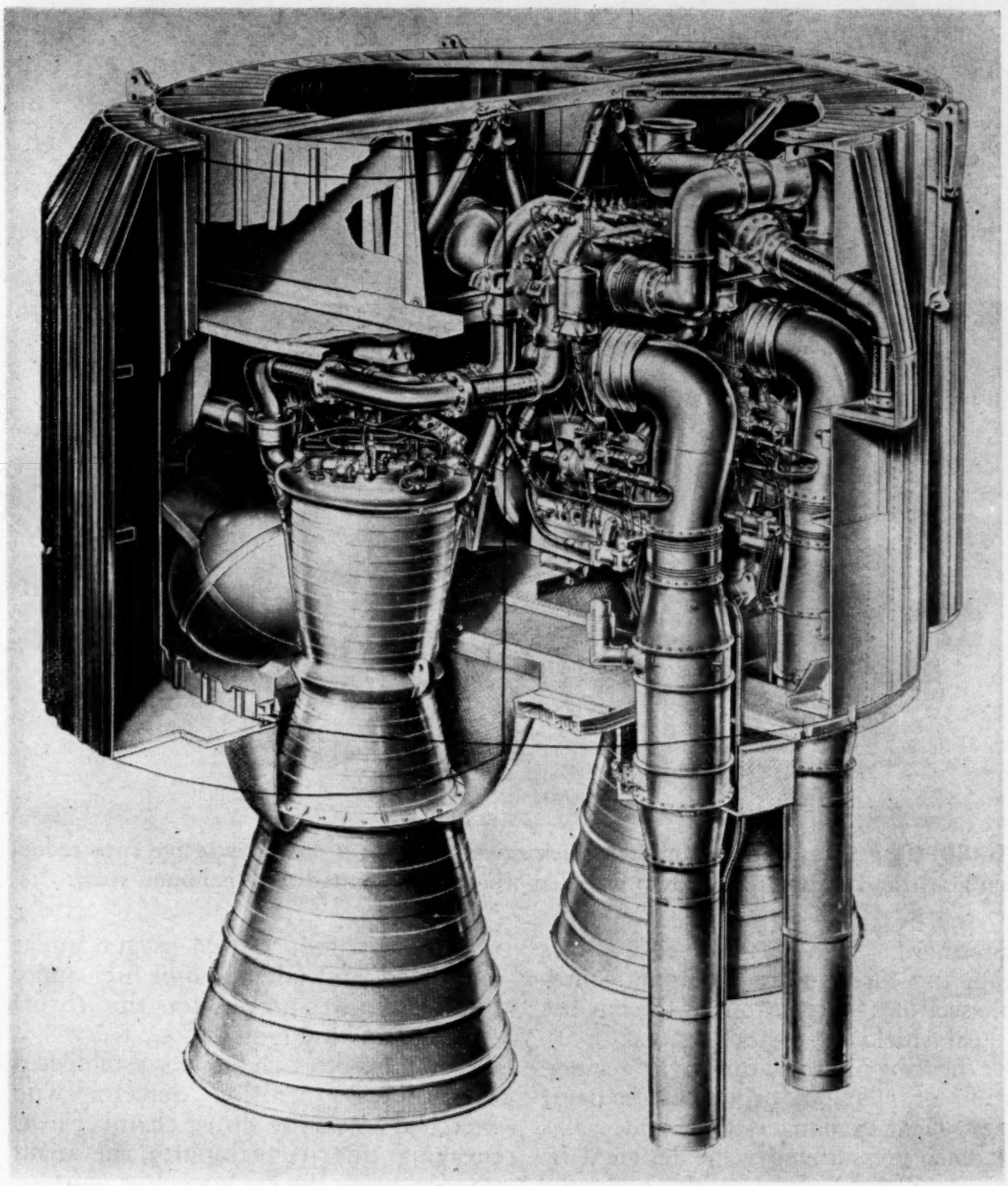
Both RZ.2 and RZ.12 have made eight runs of 150-sec. duration or more. Total test times have been 7,773 sec. for the RZ.2 and 2,532 sec. for the paired RZ.12. Tests are carried out at Spadeadam Center (AW Sept. 19, 1960, p. 116).

Some of the failures outlined by Cleaver were:

- **Liquid oxygen pump explosion**, traced to a diffuser vane fretting. Design has been altered and tested successfully on a turbopump.
- **Slow start** during one test blew the thrust chamber off. Contributory cause was a bad weld.
- **Thrust chamber and injector** manufacturing techniques were found to be critical in gaining a good running life, but Rolls feels this problem has been overcome.

Cleaver said flight engines now are being delivered to within 1½% of the specification thrust, with a further allowable 1½% run-to-run variation.

The RZ.2 engine was developed and adapted by Rolls-Royce from the Rocketdyne S.3 family which is used, with minor variations, in the Thor and Jupiter intermediate range ballistic missiles, and in Atlas booster stages. Earliest engine in the Blue Streak program was an RZ.1, virtually a copy of the S.3, of which six were built for testing while RZ.2 was on the boards.



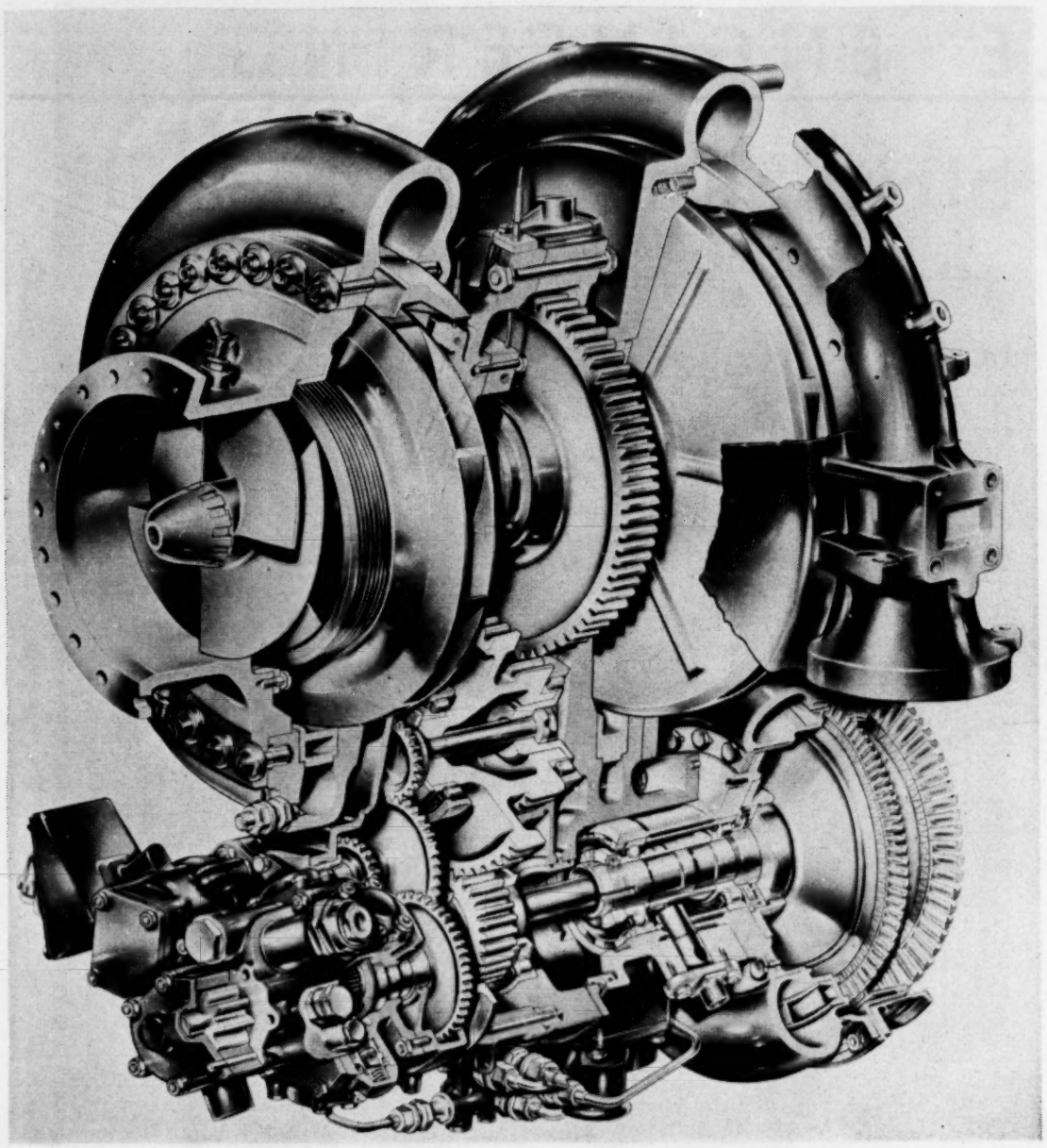
BOTTOM of propulsion bay, shown here in RZ.12 paired configuration, is fitted with heat shield. Heat exchangers are installed in extensions of two turbine exhausts to provide gases for pressurizing vehicle propellant tanks.

The complete RZ.2 engine weighs 1,500 lb. Propellants are liquid oxygen and kerosene which provide a specific impulse of 289 sec. at cutoff at about 250,000 ft. This works out to about 160 sec. of powered flight.

In the paired version of Blue Streak, each engine has a turbopump set which feeds propellants to the thrust chamber. The chamber is regeneratively cooled, since the wall is of tubular construction; total flow of kerosene traverses the chamber walls before entering the combustion chamber. Propellant pumps are driven by a turbine, which is supplied from the separate gas generator burning a very rich mixture of propellants.

In the RZ.12 paired version, the two RZ.2 engine thrust chambers are mounted directly under the main structural member of the propulsion bay; turbopumps are mounted to one side of this member. Each thrust chamber has gimbal bearing blocks at the attachment points to permit gimbaling through plus or minus 7 deg. in two planes at right angles. Cleaver said this system provides vehicle yaw, pitch and roll control without any need for separate vernier motors.

To allow for this thrust chamber



TURBOPUMP is essentially a turbine which drives, through a 488:1 two-stage spur reduction gear, the two propellant pump impellers which are mounted on a common shaft.

movement, high-pressure feed lines from the turbopumps incorporate flexible sections. The bottom of the bay has a heat shield to protect against excessive heating in this unit from recirculation of chamber or turbine exhaust gases. Heat exchangers to provide gases for tank pressurizing were designed by de Havilland, along with hydraulic jacks for gimbaling the chambers.

Engine operation is sequenced by an electro-pneumatic control system. Electrical sequencing is automatically controlled from a ground relay box and is initiated by pressing the "start" button. Valves are actuated by pneumatic servo pressures regulated to 750 psi. and taken from high-pressure bottle banks mounted in the vehicle.

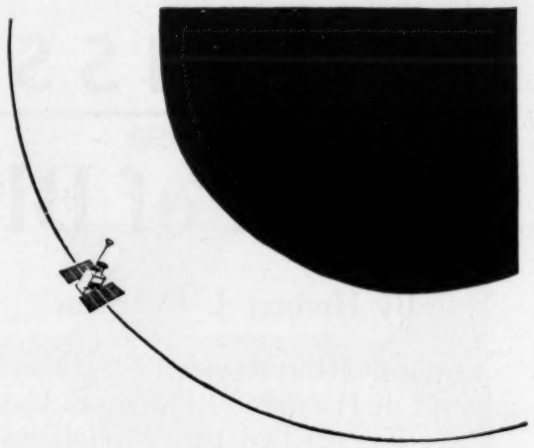
Starting Sequence

Blue Streak starting sequence, which shuts down automatically if not as programed, is as follows:

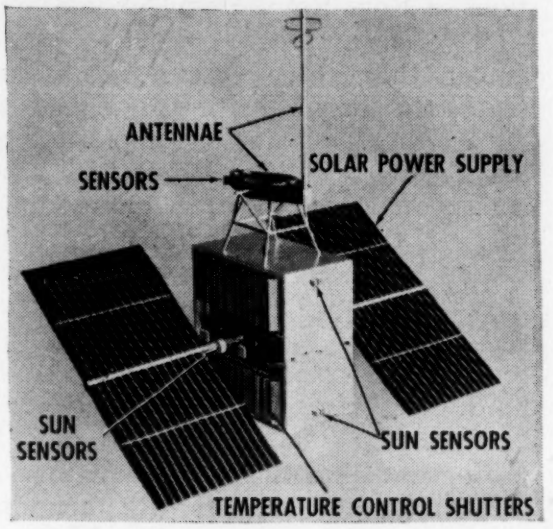
- **Start signal** initiates pressurization of ground start tanks and lubricating oil tank.
- **Firing of thrust chamber** igniter is initiated.
- **Electrical link** in thrust chamber igniter burns through and opening of main liquid oxygen valve and fuel igniter valve is initiated. Liquid oxygen under tank head, and pilot flow of fuel under start tank pressure, enter the thrust chamber and are ignited.
- **Liquid oxygen-rich flame** is established which breaks ignition detector wire stretched across the thrust chamber exit. Breaking this wire initiates the main stage by firing the gas generator igniters; links in these igniters burn through and signal main fuel valves to open.
- **Opening of fuel valves** initiates opening of the gas generator blade valve, thus supplying hot gas to the turbine which accelerates pumps and begins to feed propellants at high pressure to the thrust chamber and gas generator.
- **Fill-and-check valves** at exit from start tanks close and start tanks are vented when pump outlet pressures exceed start tank pressures. Engine is now self-sustaining and start sequence has been completed.

Automatic cutoff can occur during the ground run if certain "red-line" parameters are exceeded, such as turbine speed and liquid oxygen pump bearing temperatures. A combustion shutoff device can stop the engine if more than a preset number of vibrations occur within a specified period.

Cleaver said the time from engine



ADVENT



To create a worldwide communications system, three ADVENT satellites could be spaced equidistantly in an equatorial orbit. Each satellite, orbiting at 7000 mph, could hover in a constant position relative to the Earth, in direct line of sight of approximately one-third of its surface. ADVENT is being developed for at least one year of effective in-orbit operation. General Electric's Missile and Space Vehicle Department is developing and building the ADVENT space craft and the following subsystems:

Tracking and Command to provide position and orbit information.

Propulsion to inject the ADVENT satellite into its correct orbit.

Power to operate the communications and all other equipment—from solar energy harnessed by several thousand solar power cells; and from storage batteries for operation during eclipse.

Attitude Control to orient ADVENT's solar cell paddles toward the sun and its antennae toward the Earth.

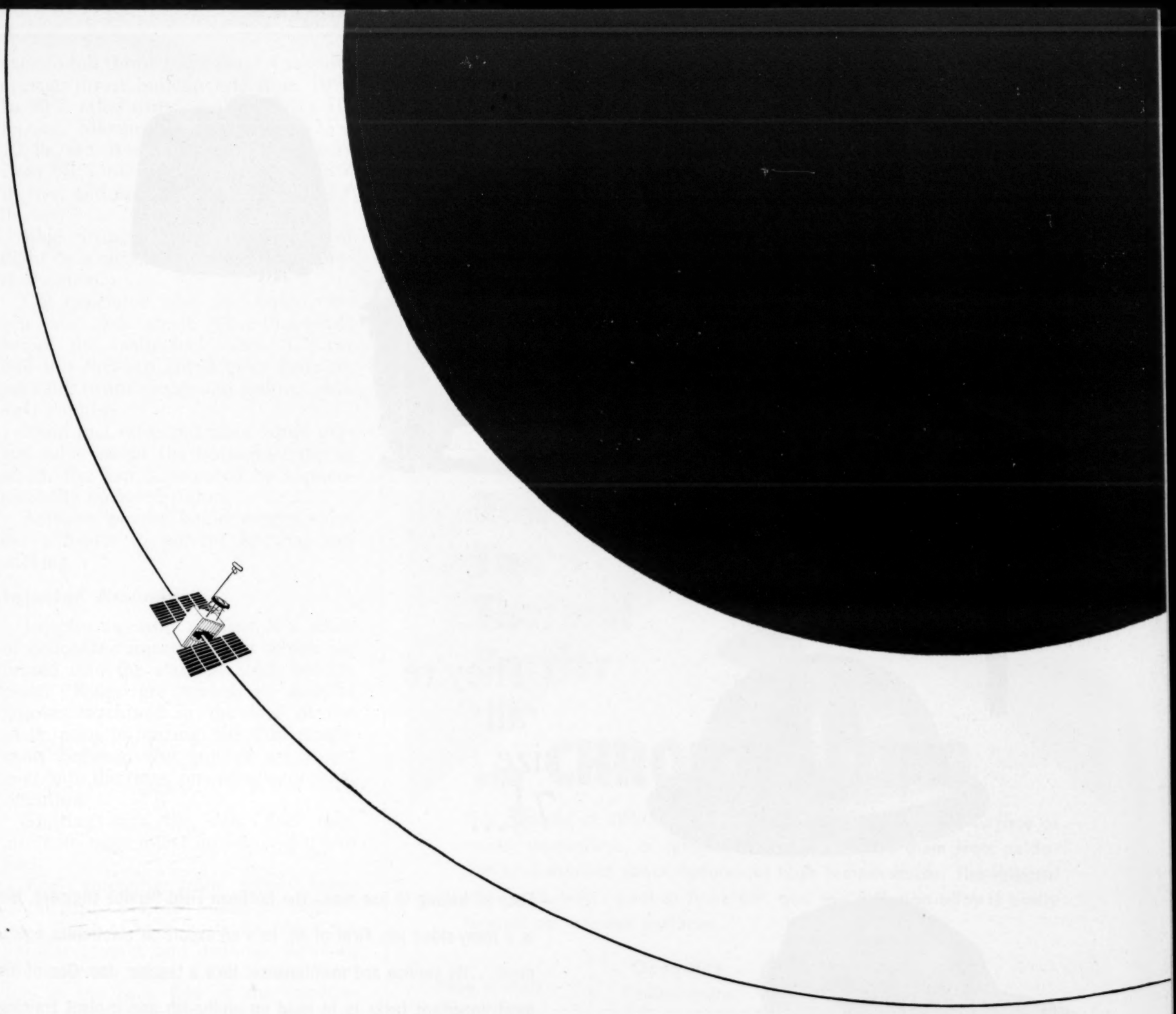
Environmental Control to keep equipment operating at the stable temperature necessary to fulfill the long-life requirements.

Telemetry to provide continuous transmission of data on equipment performance.

MSVD, a department of the General Electric Defense Electronics Division, is developing the space craft for the U.S. Army ADVENT Program under a contract with the USAF Space Systems Division.

160-02

GENERAL ELECTRIC



ADVENT is designed to be America's most advanced military communications system. Three active repeater satellites, orbiting at 22,300 miles in space, can provide instantaneous communications among U.S. government activities throughout the world. To help prove overall system feasibility, General Electric's Missile and Space Vehicle Department is developing the ADVENT space craft for the U.S. Army, under the direction of the U.S. Air Force.

GENERAL ELECTRIC

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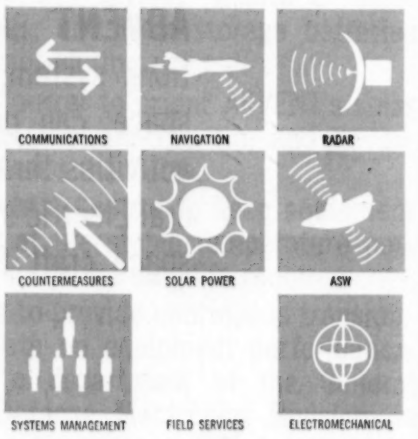

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start to full thrust takes about 4 sec. and average thrust buildup rate from 10% to 90% rated thrust is about 0.7 x 10^6 lb./sec. Maximum rate is about 2.25 x 10^6 lb./sec. Average rate of thrust decay from 90% to 10% is about 0.4 x 10^6 lb./sec. and maximum rate is 1.4 x 10^6 lb./sec.

Blue Streak can be shut down in flight by a signal from the vehicle control system.

Gas generator valve and liquid oxygen valve close about 200 milliseconds before the main fuel valve. Cleaver said this fuel-rich cutoff gives more repeatable thrust decay and reduces residual impulse.

Main fuel valve and main liquid oxygen valve are of the butterfly type, in which the flap is actuated by a pneumatically operated piston.

Actuator on the liquid oxygen valve has a heater to prevent freezing and sticking.

Injector Assembly

Injector assembly consists of a series of concentric injection rings which are brazed into the stainless steel injector plate. Rings are seated in annular grooves machined in the face of the plate; prior to brazing, the thin separations between the grooves are rolled over onto the rings, providing additional retention.

Starting with the outer fuel ring, alternate rings inject liquid oxygen and fuel.

Fuel emerging from return tubes of the thrust chamber enters the injector via a series of radia ports and then, via annular grooves and drillings, flows to the injection rings. Liquid oxygen enters at the back face of the injector. Using this construction, metal wall seals one propellant from the other during injection, eliminating the use of rubber rings.

Rolls-Royce has checked injector face temperature with thermal paint, recording up to 450C, but says the significance is not certain because some of the paint flaked away. Cleaver noted that it is believed that combustion is 50% complete about 8 in. downstream from the injector.

Japanese Self-Defense Command Revamped

Tokyo—Japanese government and Self-Defense Agency have abandoned hope for funds from the present parliament for the study of a helicopter aircraft carrier and improvements in the present air defense warning system. Two new laws have been passed, however, revamping the command organization of the Self-Defense Agency.

The command organization now resembles the U. S. system of joint chiefs. Previously, each of the three units of the Self-Defense Agency—the Ground, Air and Naval Forces—reported directly to a civilian director-general who was responsible in turn to the politically appointed minister of the agency.

Now, a chairman of the joint staff council would command all the forces in an emergency, subject to the approval of the minister of the agency. Naval air forces were transferred to the command of the chief of staff for naval forces.

Authorized strength of the armed forces was increased by 10,000 to a total of 200,000.

Lack of funds for the studies means that the Japanese early warning system will remain as it is now, a base surveillance operation.

The ratio of expenditures in the budget for Fiscal 1961 has been changed slightly in favor of materiel, but personnel expenses still take 63% of the total armed forces budget of $500 million.

In addition to the budget, Japanese forces will receive $50 million from the United States, $25 million of which will go to the Lockheed F-104J program. The Japanese Self-Defense Air Forces will receive their first F-104J this fall and hope to have a squadron operational by the summer of 1962.

This process of diffusing one or more elements into the surface of steels, superalloys, or refractory metals protects them from oxidation and thermal shock failures at high temperatures. The integral alloy case won't peel or flake off, and the diffusion alloy is easily formed on internal surfaces.

Base Metals	Operating Temperature	Applications
Steels	1500°F	Heater casings, radiants, Soldering irons cores
Stainless Steel	1800°F	Jet engine control rods
Superalloys	2100°F	Jet engine turbine vanes and blades
Molybdenum	3400°F	Space vehicle components, thermocouple tubes

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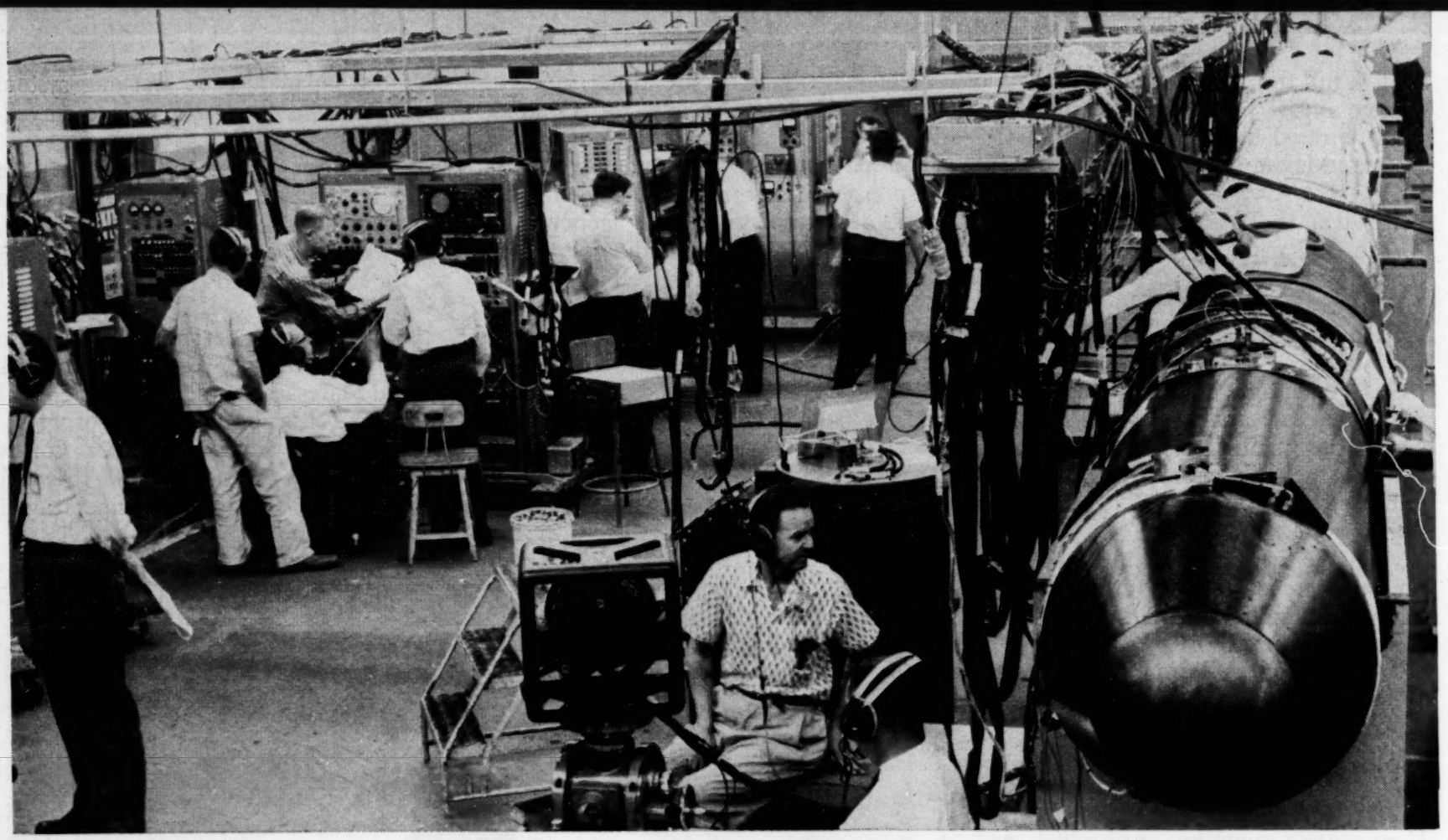
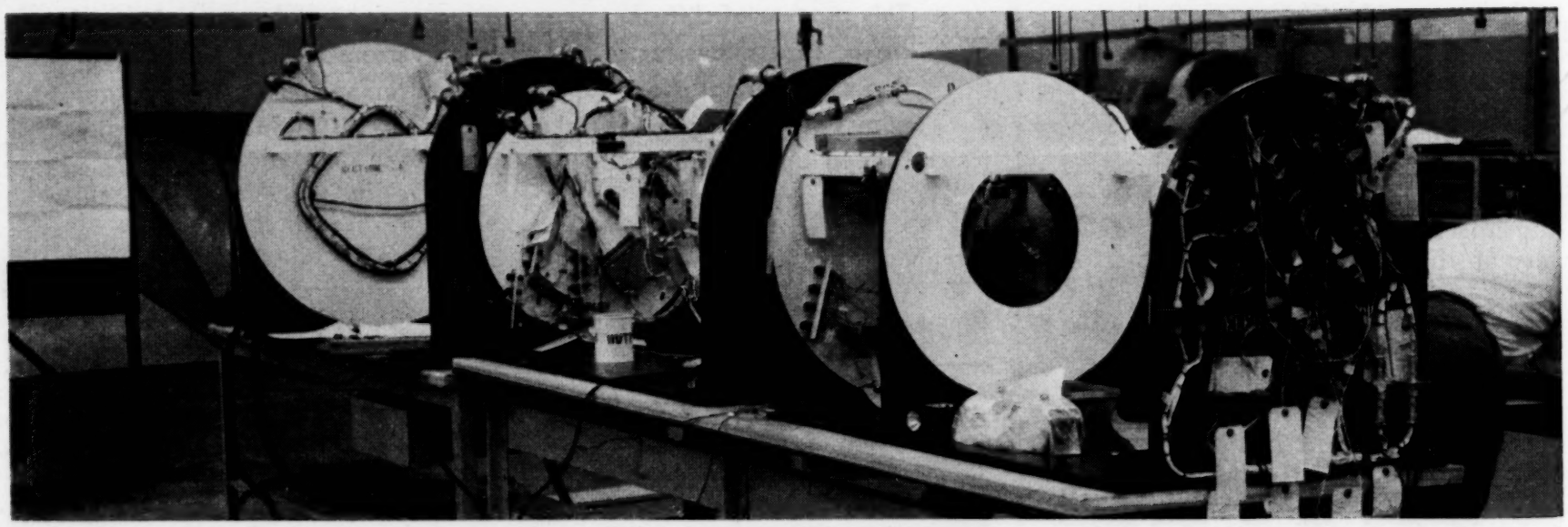
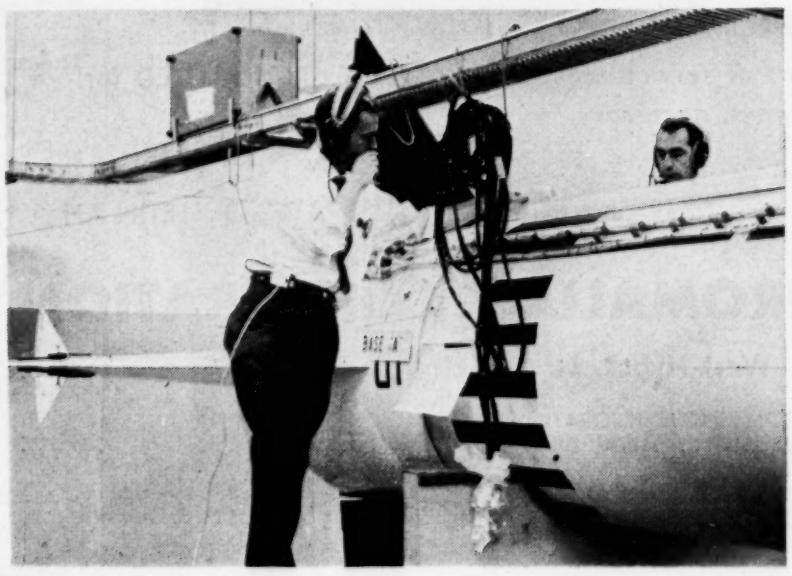


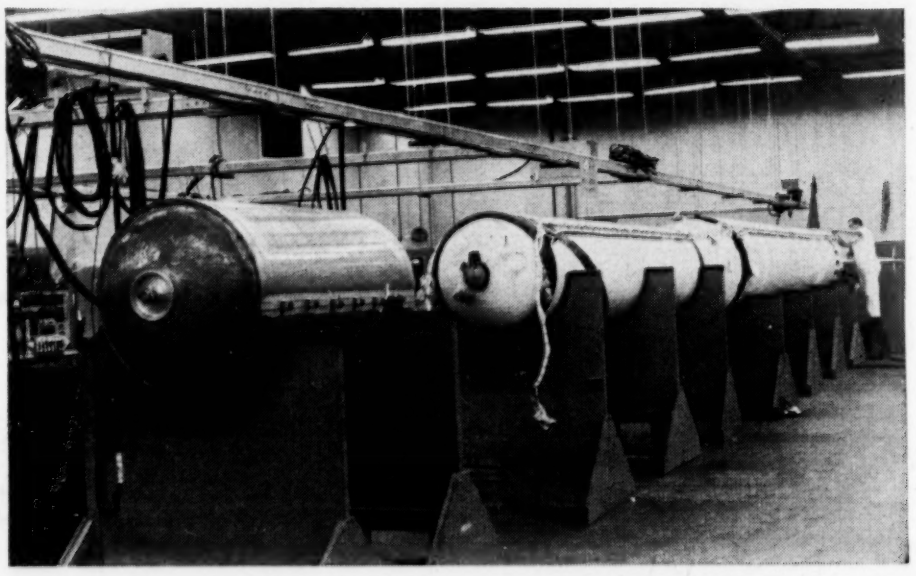
Chance Vought Astronautics Division has initiated a plant checkout procedure for the Scout launch vehicle. Vought performs all systems checks at its Dallas plant, rather than on the launch pad at Wallops Island, Va.. as was previously done.

Vought Uses Plant Checkout for Scout



Electrical evaluator (above) checks ignition and destruct systems in Vought Astronautics Scout checkout. Procedure also includes assessment of control and guidance packages (below, left) and installation of wiring harness on first and second stages (below, right).





New Technique May Detect Nuclear Blasts

Washington—Use of underground radio waves generated by an underground nuclear explosion may permit detection of clandestine nuclear blasts which would be difficult to spot by present seismic methods or to distinguish from natural phenomena such as earthquakes, Raytheon's Clark C. Abt told the recent Military Electronics Convention here.

This could open the way to an international inspection system which would be mutually satisfactory both to the U.S. and the Soviet Union.

Network of 3,000 small unattended stations in key areas of the globe, equipped with both electromagnetic and seismic sensors, may be able to eliminate most of the false alarms produced by natural causes, reducing the number of international on-site inspections required to investigate suspicious events. This has been a major stumbling block to an international nuclear test ban agreement at Geneva.

Nuclear explosions above the ground are known to produce radio waves because of the sudden ionization of air surrounding the blast, a principle exploited in Defense Department's Project Madre detection system. Theory suggests that underground radio waves also will be generated by buried nuclear blasts, but this has not been confirmed by tests.

Seismic Decoupling Problem

The principle of seismic decoupling has posed a serious obstacle to any nuclear test ban agreement. The seismic disturbance produced by an underground explosion can be reduced by sizable factors, estimated as high as 300:1, by detonating in a hole of the proper size and shape in a suitable medium. This decoupling principle was partially confirmed in the Cowboy series of high-explosive detonations in Nevada and is due for additional tests in a more ideal medium, a salt mine in Louisiana.

By reducing the seismic disturbance by a factor of 300:1, decoupling makes it far more difficult to identify an underground nuclear explosion in the presence of earthquakes and similar natural events, except by means of an unacceptably large number of detection stations and/or frequent on-site inspections, which the Soviet Union opposes.

An attractive feature of the combination electromagnetic/seismic detection system described by Abt is that decoupling is not expected to reduce the strength of the radio waves produced by the nuclear explosion. Scientists theorize that the configuration which makes seismic decoupling possible may actually increase the strength of the underground radio signal generated. And because underground radio waves are not produced by earthquakes, chemical explosions or lightning, they may provide a unique characteristic which positively identifies an underground nuclear explosion, Abt said.

Raytheon and Allied Research Associates, Inc., jointly conducted an investigation and study of a nuclear test ban inspection system, using company funds. The investigation included tests of propagation of deep strata underground radio waves, with results which indicate that very satisfactory ranges can be obtained at frequencies below 10 kc.

Abt described an Automatic Unattended Detection Inspection Transmitter system, known by the acronym Audit, which combines the proposed new electromagnetic sensors with seismic detectors. Although the number of stations required for a global monitoring system depends on the desired probability of positively detecting and identifying decoupled underground nuclear bursts and on the minimum size of detonation to be detected, Abt estimated that about 3,000 stations could provide a reasonable level of assurance. He pegged the initial cost of such a system at around $1.5 billion, with annual operating costs, including station replacement, of about $1 billion.

Each of the small Audit stations, weighing an estimated 1,000 to 2,000 lb., would be designed as a self-contained package, including electromagnetic and seismic sensors, signals analysis (data processing) equipment, radio communications equipment, tamper-warning alarm circuits and electric power supply.

Because many of the stations may be situated in remote sites, they would be constructed as truck-transportable or air-transportable units which would require a minimum of installation effort. Electric power might be supplied by solar cells or wind-driven generators. However, a station also would have an emergency battery supply which would enable it to broadcast an alarm in the event someone accidentally or intentionally blocked its main source of electric power.

To hold down the amount of electric power required by an Audit station, Abt proposes to minimize the amount of information which it must transmit by doing much of the signal analysis at the site. Thus the station would transmit an alarm only when it had received both seismic and electromagnetic waves whose correlation suggested a clandestine nuclear explosion in the vicinity.

Otherwise the only transmissions from each of the Audit stations would be a periodic "all's well" signal to indicate that the station is still operational.

Spacing Factors

Geographic spacing between individual stations would depend on many operational and political factors—for example, the suitability of the terrain for decoupled underground nuclear blasts, the desired probability of being able to detect an underground blast of the desired minimum size, the relative accuracy with which the location of a suspicious event can be pinpointed, and the reliability of individual stations. Another important factor, related to probability of detection, is the acceptable rate of false alarms, which would require on-site inspections.

Present studies suggest that between five and 10 stations within seismic and electromagnetic wave range of any possible site of an underground blast would be needed to provide a high probability of detection with low probability of false alarm, and to accurately pinpoint suspicious event locations, Abt said.

Because of electric power supply limitations, the Raytheon-Allied Research study suggests that each station must also be used as a radio relay for communicating with an Audit system control center, rather than attempting to enable each station to communicate directly over several thousand miles.

However, the network must be such that outage of one or two stations would not produce major blackouts in system coverage. Abt proposes to use a "chain-reaction network," in which any station can serve as an intermediate relay for others in the vicinity. This means that all stations must operate at the same radio frequency and with the same coding so that any one can serve as a relay for any other station in the network, but without mutual interference. Abt said that Raytheon recently has developed a new coding technique which permits chain reaction propagation without interference.

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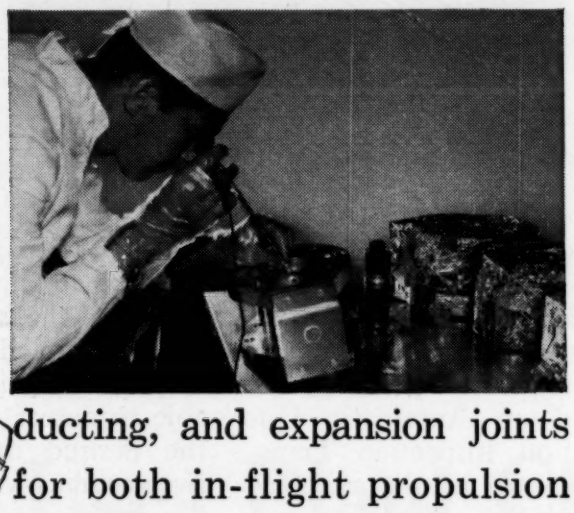

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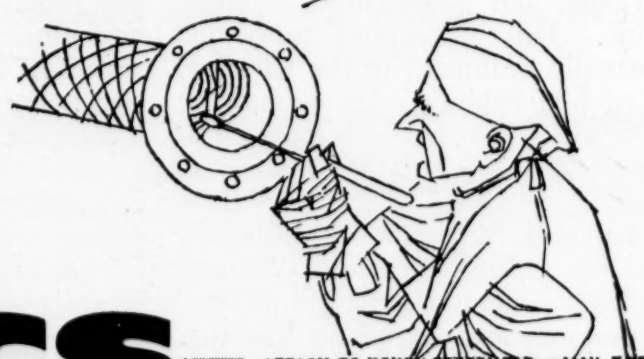

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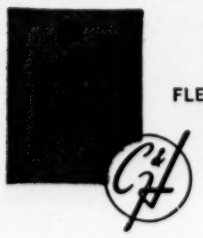

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ranges and a non-real-time coding system. The new coding system transfers real-time transmissions in a receiver so that the output signals occupy only a fraction of the required transmission time. If the output information from each station is sampled at the fundamental transmission data rate, all Audit stations can operate on the same frequency without interference, he said.

The coding technique used also provides considerable security against accidental or intentional jamming, according to Abt.

Abt does not minimize the problems of preventing an Audit system from being incapacitated of fooled, either accidentally or intentionally. A sizable portion of his report presented at the Military Electronics Convention dealt with possible countermeasures and means required to combat them. However, the fact that the proposed system employs both seismic and electromagnetic detection, with cross-correlation of the two, makes the system considerably more difficult to fool than one using only seismic detection, he believes.

For example, it has been suggested that detonation of a number of conventional explosives, suitably spaced in both time and geographical location, could be used to mask an underground nuclear explosion or its location. But this technique, Abt believes, would not be effective against Audit because the chemical explosions do not generate electromagnetic waves. Another approach, detonating a clandestine nuclear blast at a time of high earthquake disturbance, also would be unsuccessful for the same reason.

Abt concedes that it might be possible to reduce the expected electromagnetic waves by shielding the underground site with a copper or carbon lining. However, this would greatly increase the cost of clandestine testing and might produce the opposite result of reducing the seismic decoupling effect.

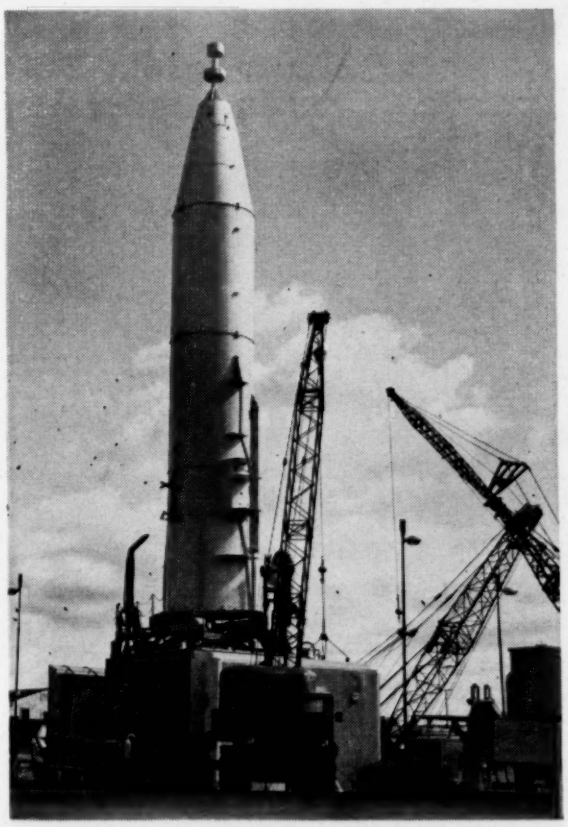
Audit Alarm

A more direct approach to disabling the Audit system would be to put a number of its stations out of action in the vicinity of the intended clandestine explosion. However, each station would be equipped with an alarm which would be triggered whenever someone tried to enter or otherwise tampered with the station. If a large number of stations were suddenly to be dynamited out of existence before the alarm sounded, the sudden loss of many stations would itself arouse suspicion and call for an on-site inspection team investigation.

A more indirect approach for a test ban violator would be to jam signals from the Audit stations in the vicinity of the clandestine explosion. However, this jamming would be immediately apparent to the Audit control center and would itself pinpoint the location of the violation. Another possibility is for a violator to build pseudo Audit station transmitters and send out false "all's quiet" reports during the explosion, but this would not deny the Audit headquarters access to the real station transmitters which would be indicating a probable violation.

As Abt sees it, the Audit system designers need only ensure that any active countermeasure is positively identified as such and not as a natural occurrence. Unless a country were positive that it could disable or fool the Audit system without being detected, it would not be likely to run the risk, Abt believes. What action should be taken if such intentional countermeasure is detected is a question that Abt leaves to others.

If agreement could be reached now to proceed with such a system, Abt estimates that it could be in production by 1964 and ready for deployment the following year. Abt is manager of preliminary systems design at Raytheon's Missiles and Space Division, Bedford, Mass.



Boilerplate Atlas F

Iron Atlas F, filled with 28,000 gal. of water, is being used at Vandenberg AFB, Calif., in tests of the electrical and launch platform drive subsystems of the silo launcher system. Platform drive is being checked for elevator acceleration, stability under loading and dependability. The 80-ft. tall, 10-ft. diameter shell approximates the dimensions and, when fully loaded, the weight of the F-series missile. Dumbbell-like weight atop simulator simulates weight distribution of warhead. Operational Atlas Fs, stored in 174-ft deep silos, will be raised to surface before firing.

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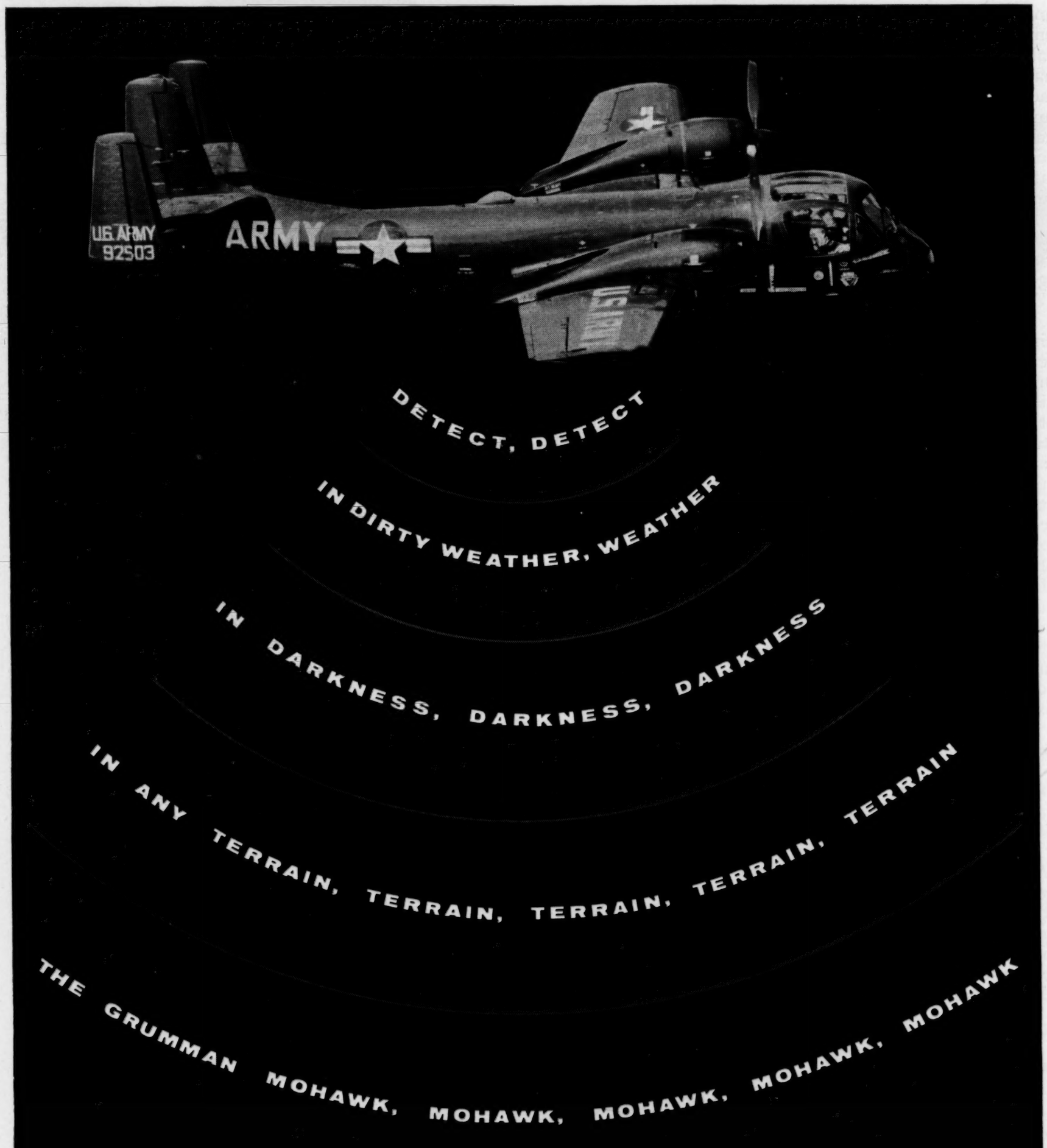

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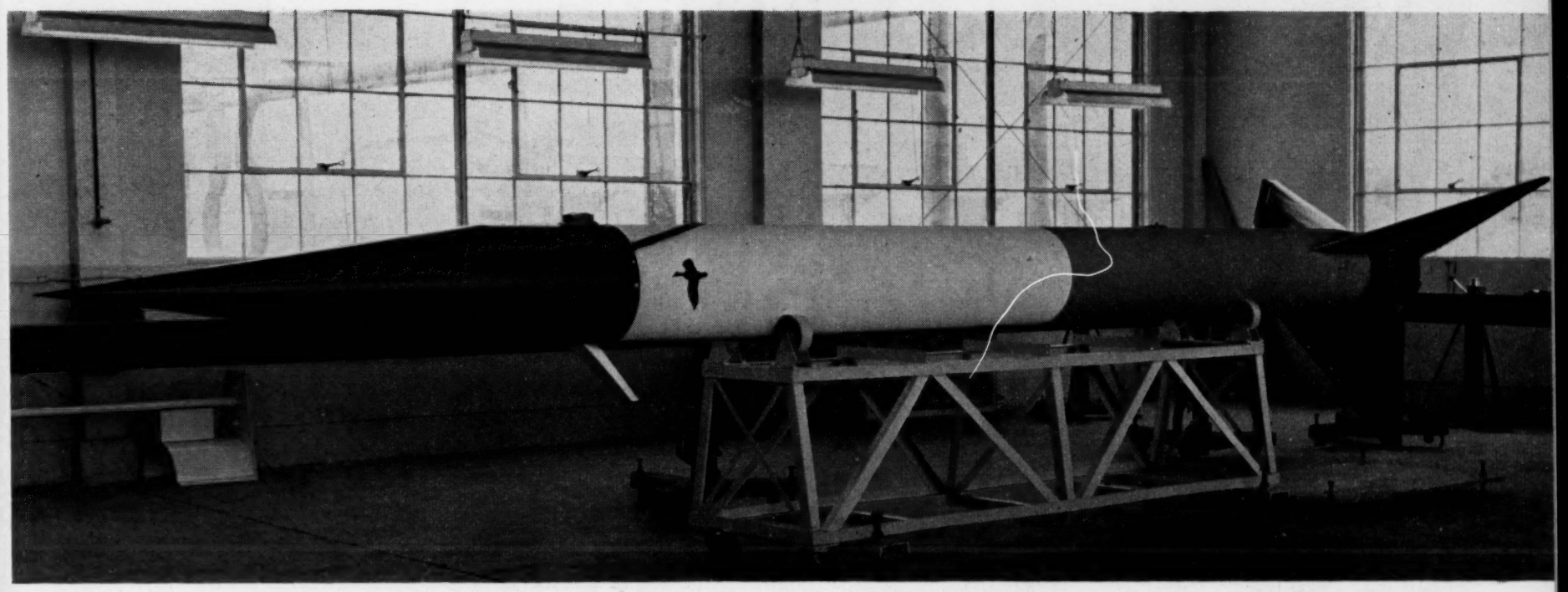
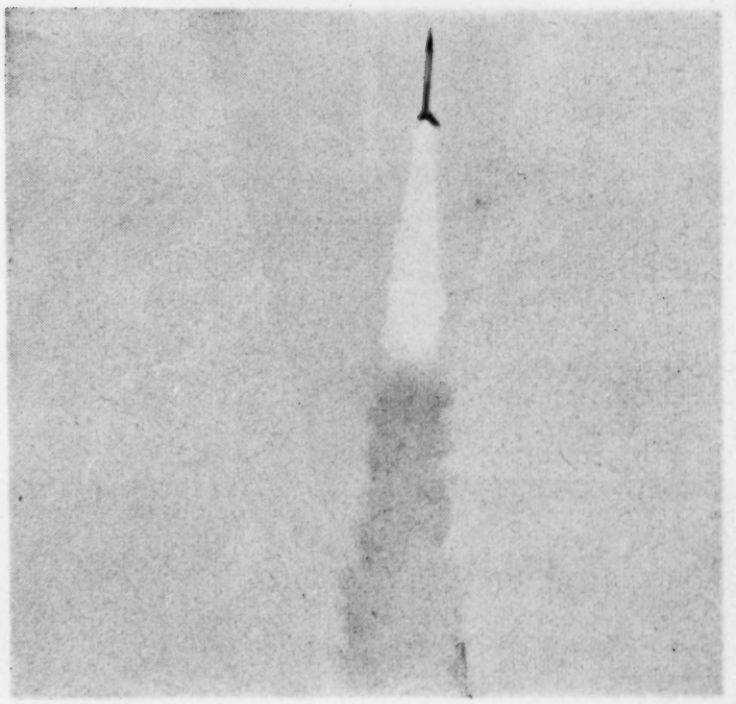
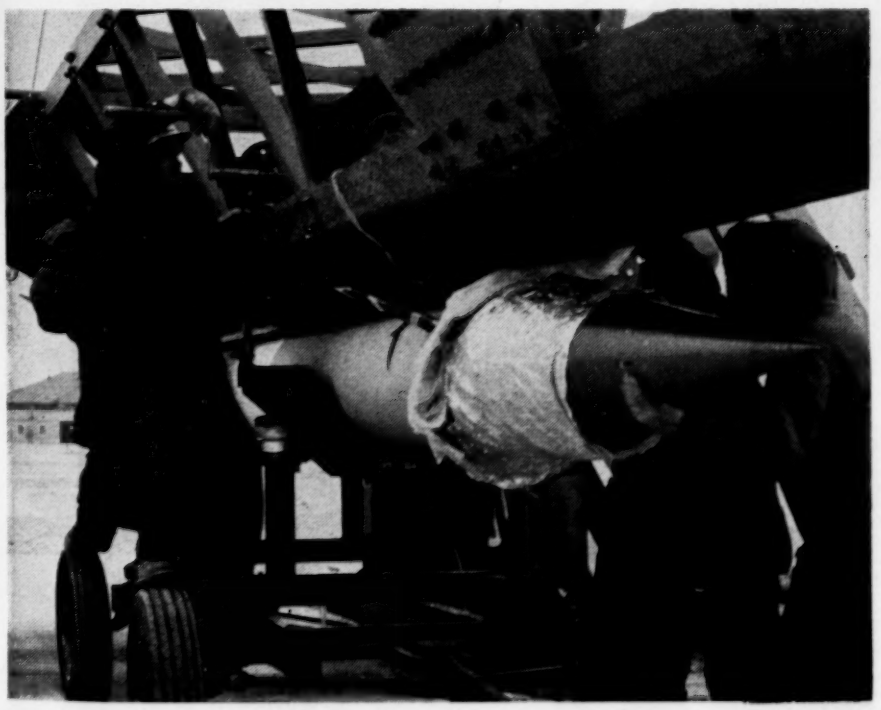


Black Brant IV, two-stage Canadian-developed research rocket, will separate and each stage become a one-stage vehicle (Black Brant V and VI). The first stage, successfully static fired in 1959, develops 20,000 lb. thrust for 20 sec.

Canada Tests Black Brant Missile; Seeks Defense, NASA Interest

Canadian Armament Research and Development Establishment (CARDE) and Bristol Aero-Industries, Ltd. are developing a family of three Black Brant research rockets able to carry scientific payloads of 25-250 lb. to altitudes up to 600 mi. Canada is attempting to interest the National Aeronautics and Space Administration and the U. S. Defense Department in the all-solid rocket system as part of the bilateral defense production sharing program. First development flights used test vehicles called Black Brant I and II (below and right) to test stability, propellant combinations and motors in launches from Ft. Churchill. Black Brant IV (top) is a model of the two-stage system. Two single-stage versions also are planned, each using a stage of the Black Brant IV. The Black Brant research program began in 1958 with the launch of 50 8-in. rockets to check propulsion systems, and the first stage of Black Brant IV was first static fired in 1959. It developed 20,000 lb. thrust during its 20 sec. burning cycle. CARDE plans to launch full scale prototypes of the three Black Brants next year. Nose cones and fins are fabricated by Canadair, Ltd., and Bristol Industries builds the rocket casings. Highlight of development flights to date occurred last fall when a cloud of nitric oxide was released from a Black Brant I nose cone 60 mi. above Ft. Churchill to assess the effects on oxygen atoms of the rocket's passage through the atmosphere. Additional upper atmosphere experiments are planned this year.





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Chromium
3.5-minute exposure

NEW BLIND-LANDING SYSTEM, called Flarescan Instrument Landing System (FILS), adds a precise flareout reference to existing ILS installations. New system, developed by AIL Division of Cutler-Hammer, is shown under test using a Bendix B-25 aircraft at MacArthur Field, N. Y., prior to delivery of a system to Federal Aviation Agency for evaluation at its Atlantic City facility.

FAA to Test Flareout Guidance System

By Philip J. Klass

MacArthur Field, N. Y.—New all-weather landing system, designed to add a precise flareout path to existing ILS beams, will be delivered this month to Federal Aviation Agency's National Aviation Facilities Experimental Center at Atlantic City, N. J., for flight evaluation this fall.

The new Flarescan Instrument Landing System (FILS) was developed by Airborne Instruments Laboratory, Deer Park, N. Y., now known as the AIL Division of Cutler-Hammer, Inc.

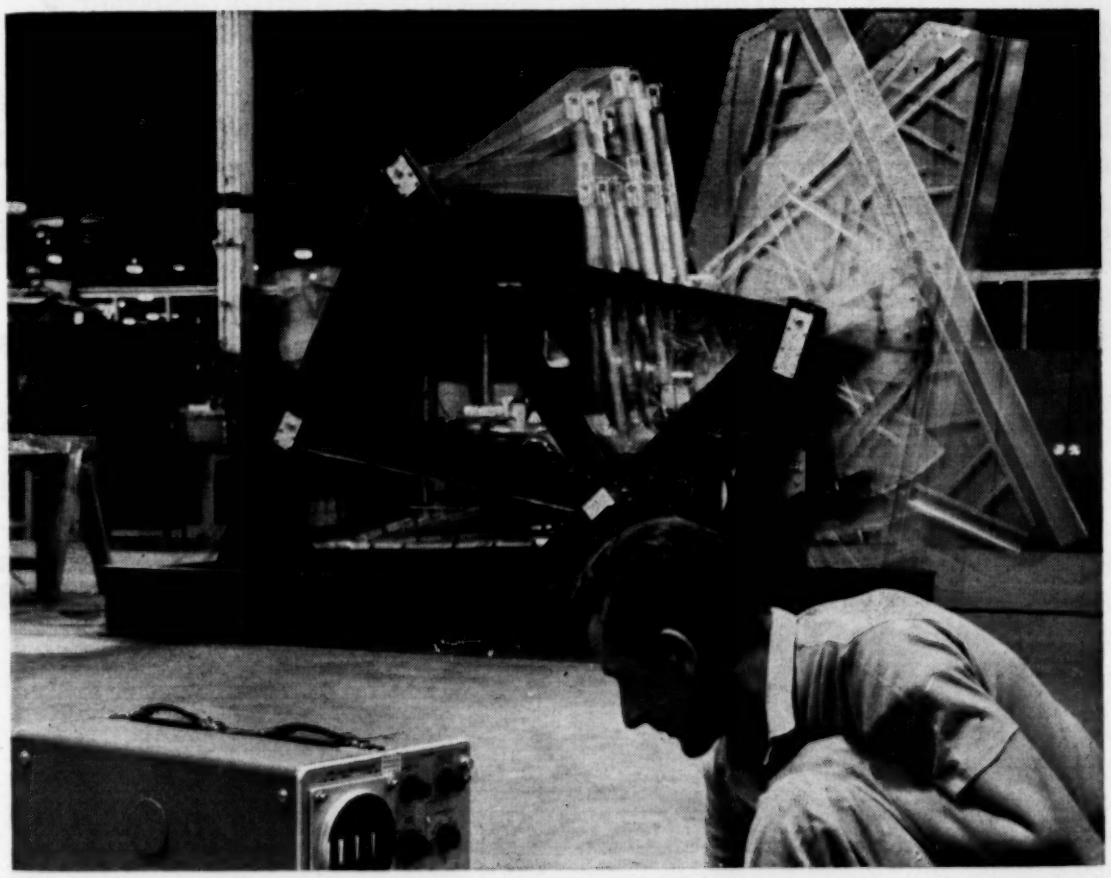
FILS is a ground-based system that produces an extremely large number of precise microwave beams which radiate from the runway and intersect the existing ILS glide slope beam. The system permits transition from glide slope to flareout at any desired altitude and provides a wide range of possible flareout paths. FILS also can be used to provide steep angle approaches by helicopters.

The only new airborne equipment required is a microwave receiver-decoder. Present AIL estimates indicate that the airborne unit would weigh less than 20 lb., or less than 40 lb. in a dual version.

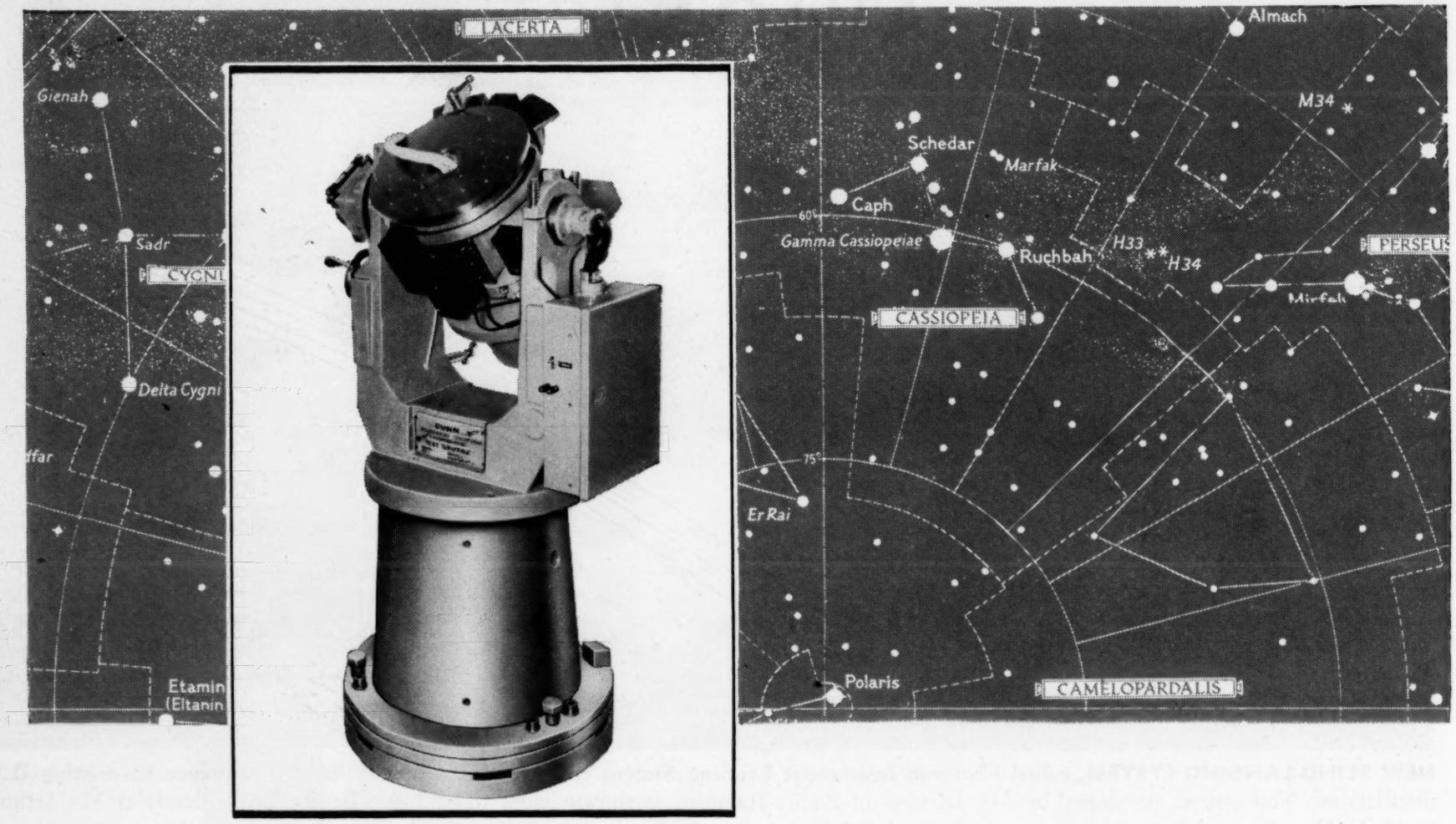
The FILS system, demonstrated to AVIATION WEEK here at MacArthur Field on Long Island, N. Y., is an outgrowth of AIL's work on a completely new instrument approach and landing system originally conceived as a potential replacement for existing ILS. AIL started its work in 1958, with company funds.

The original system was called EAGLE, an acronym for Elevation Angle Guidance Landing Equipment.

A few months ago AIL altered its approach after its studies suggested that the heavy investment in ILS ground and airborne equipment around the world made it unlikely that this



FLARESCAN antenna moves through a 40-deg. vertical sweep, transmitting pulses whose repetition rate (spacing) is proportional to antenna's elevation angle. This produces many precise microwave beams, each at a slightly different angle. Photo above shows antenna motion by means of multiple exposure. FILS transmitter operates at 16,000 mc.



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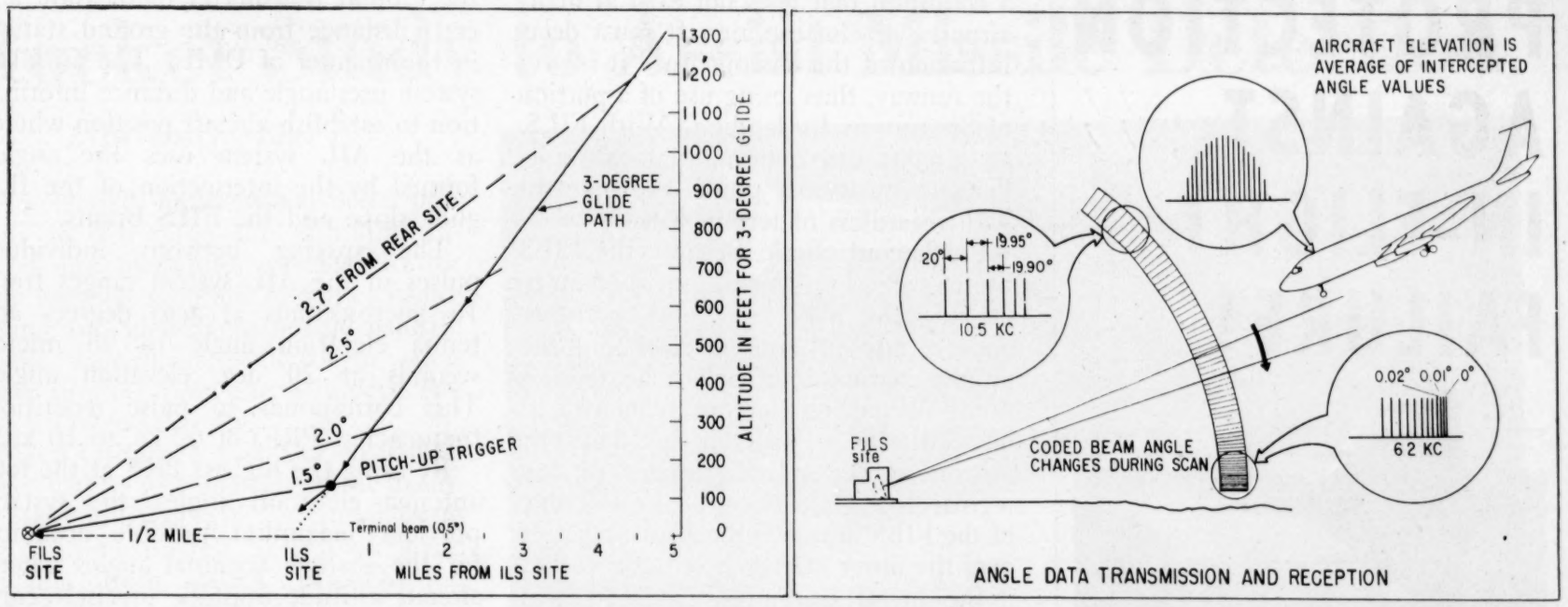


FILS uses a vertically scanning microwave antenna located one-half mile farther down the runway than present ILS glide slope antenna to provide large number of precise beams which intersect glide slope beam. Pilot, by selecting any one of FILS beam intersections with glide slope, can determine precise altitude and point where he starts flareout maneuver (pitch-up trigger). Cockpit indicator then switches to display aircraft position relative to shallow (terminal) angle FILS beam which brings aircraft to touchdown. FILS beams are produced by varying spacing between transmitted pulses as a function of antenna elevation angle (right). Scale at left is exaggerated for ease of viewing.

existing system would be replaced in the near future. The company therefore decided to apply the same techniques to add flareout provisions to existing ILS installations.

The new AIL system uses a vertically scanning antenna, located off the edge of the runway approximately 2,500 ft. farther down the runway than the present ILS glide slope antenna. This new FILS antenna generates a signal which, in effect, produces a large number of new glide slope-type beams, each at a slightly different angle relative to the horizontal.

Each of the FILS beams intersects the ILS glide slope beam at a slightly different altitude and distance out from the runway. By means of the airborne FILS receiver, which can be pre-set to indicate when the aircraft has intercepted any one of the desired FILS beams as it comes down the ILS glide slope, it is possible to select the precise point and altitude at which the aircraft begins its flareout maneuver.

Additionally, the pilot selects the final FILS shallow glide path angle, called "terminal angle," which is optimum for his type aircraft, during the final moments of the flareout.

Bendix Aviation's Eclipse-Pioneer Division has been working closely with AIL in flight tests on the new FILS, using a specially instrumented Bendix B-25. The airplane also is used in flight tests of the Gilfillan REGAL all-weather landing system.

Bendix holds an FAA contract to develop a flareout coupler for REGAL, intended to permit fully automatic flareout and landing using an autopilot. The company is negotiating a similar contract with FAA for an automatic flareout coupler for FILS.

The Bendix engineering flight test crew has made approximately 35 FILS landings here at MacArthur during the past month and earlier had made about 50 flight runs to check performance of different terminal angle paths.

In the present experimental B-25 installation, the ILS approach and FILS flareout are made manually using a Bendix flight director for the former and a separate cross-pointer indicator to display flareout/landing guidance to the pilot. (In a production version, both approach and flareout guidance probably would be displayed on a single cross-pointer type indicator.)

In operation, as the aircraft proceeds down the regular ILS glide slope toward the pre-selected flareout transition point, the horizontal pointer of the FILS indicator slowly moves up toward mid-scale (on-beam) position. When the selected transition point is reached, an indicator lamp comes on and the B-25 pilot switches his eyes from the ILS indicator to the FILS indicator. (In a flight demonstration for AVIATION WEEK, the transition point selected was the intersection of the 1.3-deg. FILS beam with the ILS glide slope beam, which makes an angle of 2.6 deg.)

Simultaneously, the FILS indicator is switched to display the relative position of the terminal angle beam selected by the pilot and the horizontal pointer moves to the bottom of the indicator. (For the demonstration runs, this terminal angle selected was 0.35 deg.) The pilot pulls back on the stick to center the horizontal pointer and maneuvers to keep it centered, causing the aircraft to fly a flareout path. The point on the runway at which touchdown occurs depends upon the terminal glide angle selected and the height of the aircraft's antenna above the base of the wheels. For the Bendix B-25, with its FILS antenna situated 11 ft. above the base of the wheels, touchdown normally occurs about 1,000 ft. upstream from the FILS antenna.

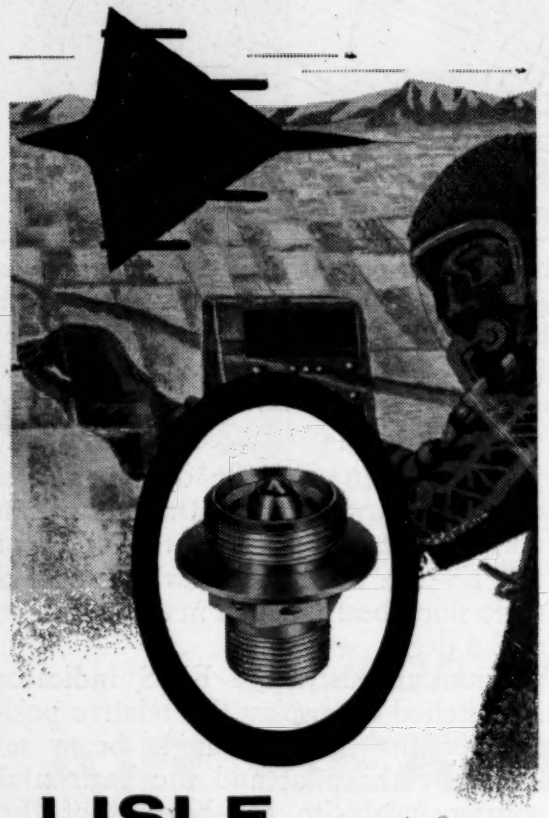
AIL's George B. Litchford, who heads the firm's Aviation Systems Research department, believes that FILS offers a number of attractive advantages:

- **Evolutionary:** Because FILS is designed to complement ILS and extend its capability rather than replace it, it can be introduced on an evolutionary basis at those airports where all-weather capability is most urgently needed.
- **Altitude-position checks:** By means of a simple airborne computer to perform triangulation calculations.
- **No terrain problems:** Flareout systems which use an airborne radio/radar altimeter to measure aircraft height above the ground to compute flareout maneuver require that terrain on the path to the instrument runway be flat,

What's in a Name?

One of the biggest challenges to designers of new projects, programs and systems is to devise a multi-word name whose first letters form a catchy acronym. The original Airborne Instruments Laboratory concept for a new all-weather approach and landing system was called EAGLE – Elevation Angle Guidance Landing Equipment. Gilfillan's new blind landing system is called REGAL– Range and Elevation Guidance for Approach and Landing. This has prompted some wags to speculate that the next blind landing system that points the way to the runway may be called BEAGLE– Better Elevation-Azimuth Guidance Landing Equipment.

PROTECTION AGAINST IN-FLIGHT FAILURE!



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a condition that does not exist at many airports, or else the aircraft must delay initiation of the flareout until it is over the runway, thus losing use of a portion of the runway for landing. With FILS, an aircraft can determine its altitude, flareout transition point and flareout path regardless of terrain flatness.

• **Pre-flareout check:** Because the FILS beams extend out for distances of up to 20 mi., the pilot can check performance of his airborne receiver and the ground station long before he reaches point of starting flareout maneuver at low altitude. This can be done by measuring the relative angles of the regular ILS glide slope beam and one of the FILS beams as the airplane passes over the outer marker beacon, or earlier if the aircraft and airport are equipped with distance measuring equipment.

Improvements Needed

Litchford concedes that effective use of FILS may require improvements in some less-than-optimum existing glide slope installations. To achieve desired accuracies, the FILS antenna needs to be located approximately 2,500 ft. behind the glide slope antenna. At airports where the terrain immediately preceding the runway is not smooth, a conventional glide slope antenna must be located back some distance along the runway, which pushes the FILS touchdown point correspondingly farther down the runway—a disadvantage for airports with short runways.

However, a recently developed waveguide-type antenna, which does not require ground reflected energy to produce the glide slope beam and therefore is independent of approach terrain, can be used and positioned at the start of the runway, Litchford says.

The new AIL system operates in the microwave band at a frequency of 16,000 mc. to give the precision beam required for flareout. The vertical scanning antenna is a modified pillbox type that produces a fan-shaped beam in azimuth which is flat in the vertical plane, having a thickness of ½ deg.

As the FILS antenna scans vertically, it transmits a series of pulses which automatically are coded to indicate the antenna's elevation angle at any instant. The coding takes the form of varying the pulse repetition rate and therefore the time spacing between individual pulses. This, in effect, produces the many individual FILS beams, each with its exclusive identification.

As the antenna's beam sweeps past an airplane's small microwave antenna, the airborne receiver need only measure the spacing between individual pulses to determine which of the FILS beams it has intercepted. In this respect, AIL's system resembles Gilfillan's REGAL. However, the latter uses an additional airborne transponder which interrogates the ground transmitter to measure aircraft distance from the ground station in the manner of DME. The Gilfillan system uses angle and distance information to establish aircraft position whereas the AIL system uses the angles formed by the intersection of the ILS glide slope and the FILS beams.

The spacing between individual pulses in the AIL system ranges from 16 microseconds at zero degrees antenna elevation angle to 96 microseconds at 20 deg. elevation angle. This corresponds to pulse repetition frequencies (PRF) of 62 kc. to 10 kc.

By using the highest PRF at the low antenna elevation angles, the system provides maximum possible accuracy for the shallow terminal angles where aircraft altitude must be precisely controlled, according to Joseph Woodward, FILS project manager.

Static measurements made by AIL engineers, using a microwave antenna hoisted to various heights above the ground, indicate the new system can provide angular measurements with errors of less than 0.05 deg. (one milliradian) throughout its 20-deg. elevation angle range, according to Woodward.

This is the equivalent to an error of only five feet altitude at flareout transition point when the airplane's altitude is approximately 150 ft.

The ground-site antenna is designed to scan over a 40-deg. vertical sector, only half of which is used for beam transmission, at a rate which causes it to sweep past an aircraft up to 10 times per second. This comparatively rapid scan rate, coupled with the moderately high PRF, makes it possible for the system to provide first derivative data indicating rate of change of aircraft altitude for use by flareout computer circuits and by the autopilot coupler, according to Litchford. The FILS antenna was designed for AIL by Rabinow Engineering Co., Washington, D. C.

The moderately fast sector scan rates used in the FILS antenna produce high stresses on the antenna structure which suggest that it might not provide the long trouble-free service life which FAA requires for its facilities. With this in mind, AIL has developed an unusual type of sector scan mechanism with a minimum of moving parts which shows great promise of extremely long life. But pending application for patents, the company is close-lipped over details.

To supplement company funding, AIL has received FAA contracts covering static tests on FILS beam flatness and accuracy and for installation of a second system at Atlantic City. Meanwhile, the company plans to continue its own flight tests with Bendix here at MacArthur Field.

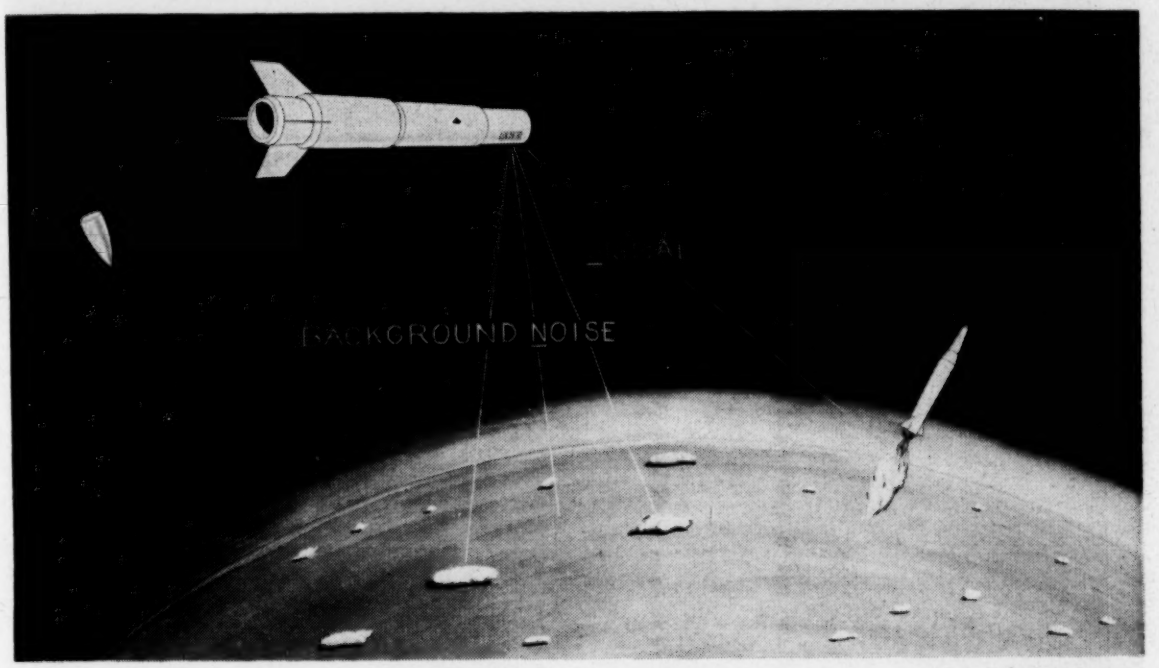
Rocket Study to Assist Missile Detection

By Barry Miller

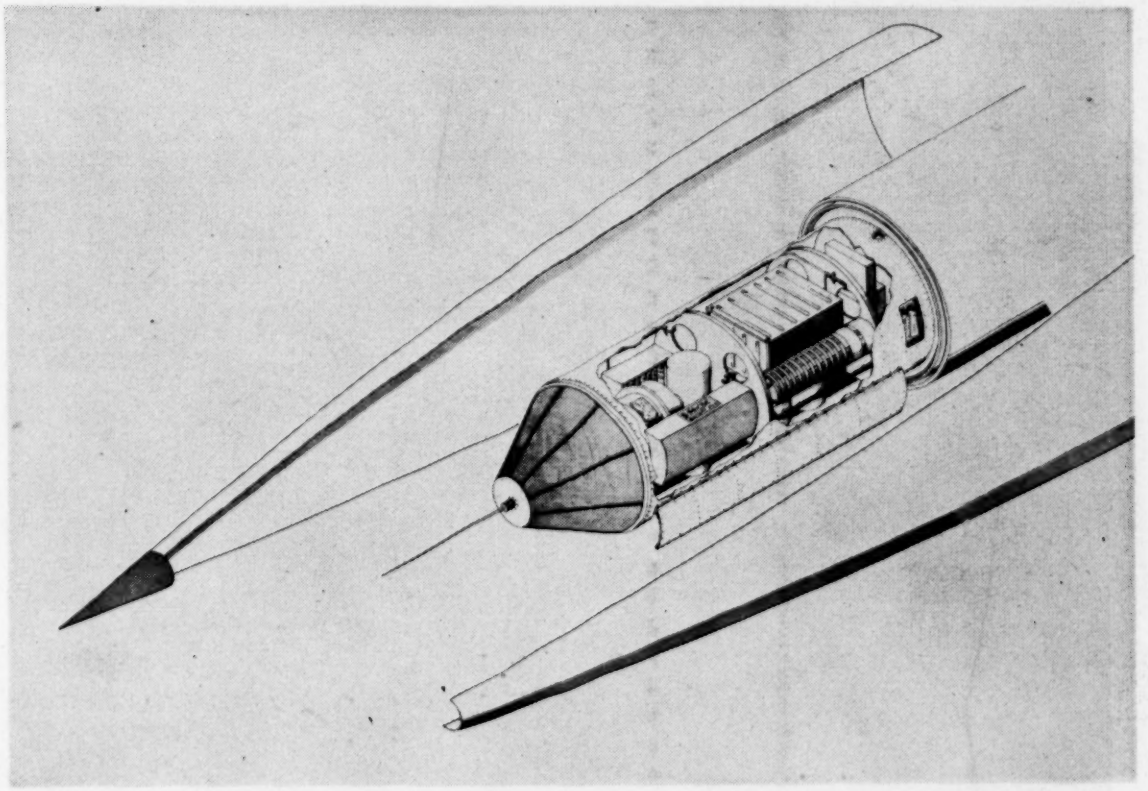
Accelerated, multi-million dollar program to determine the optimum infrared and ultraviolet wavelengths for early warning satellites to sense, in detecting and identifying hostile ballistic missile launchings, will begin soon under funding from the Advanced Research Projects Agency.

Naval Ordnance Test Station, China Lake, Calif., will administer the measurement program with an initial funding of approximately $2 million made available from ARPA through the Navy's Bureau of Weapons.

The program will involve gathering and analysis of data on infrared, visible and ultraviolet radiation secured by instruments contained in the nose cones of three series of high-altitude rockets to be fired separately from several sites in the United States, Canada and Norway.



RADIOMETERS in the series of high-altitude rocket firings will sense electromagnetic radiation from missile exhausts as well as background sources. Tests are attempting to enable scientists to locate those wavelengths in selected infrared and ultraviolet bands on which maximum signal-to-noise ratios may be expected in detecting missile launchings.



EXPLODED VIEW shows instrumentation payload projected for a new high-altitude rocket study seeking optimum infrared and ultraviolet wavelengths on which to detect ballistic missile launchings from short wavelength electromagnetic emissions in their booster exhausts during powered phases of the launchings.

Short Wavelength

Short wavelength electromagnetic radiation emitted in the northern portion of the Western Hemisphere by the earth, natural phenomena and our own R&D ballistic missile launchings will be monitored by the vertical rocket probes. From information obtained in the program, scientists hope to decide which are the best wavelengths, given existing technology, problems of interfering radiation from natural phenomena, etc., for missile warning satellites to detect missile launchings by the infrared and ultraviolet radiation emitted from their booster exhaust flames.

In another program designed to satisfy similar needs, the Air Force recently awarded Lockheed Missiles and Space Division a contract for target-to-background infrared study.

Initial rocket launching in the program is scheduled for September or October of this year. Final shots should be completed by the end of 1962. No multiple launchings are contemplated. Aerobee or Astrobee rockets, made by Aerojet-General, will be the vehicles for the program.

Spectral Region

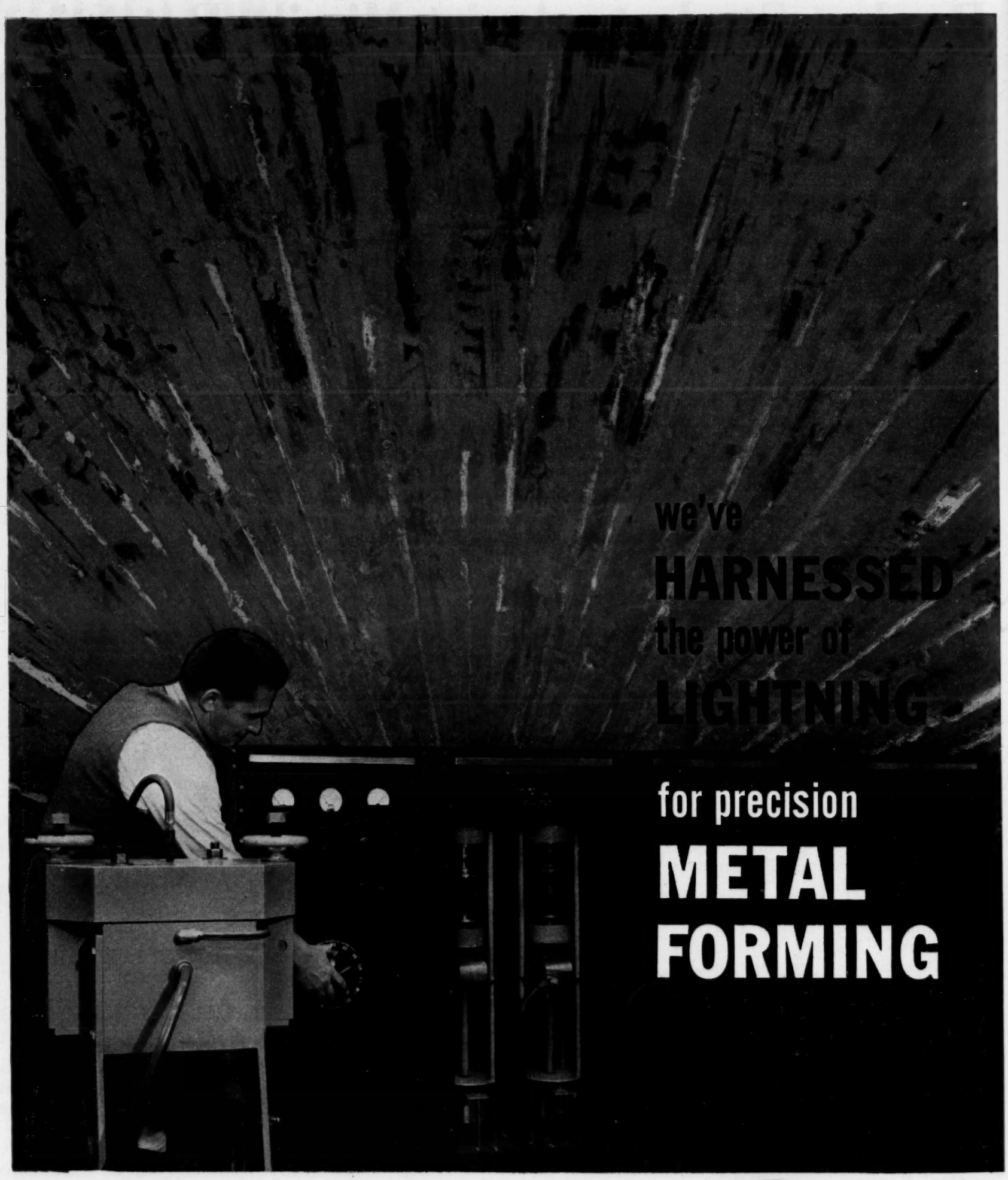
Each rocket will contain radiometers capable of detecting infrared and ultraviolet emissions. The far infrared spectral region which requires more complex cooling mechanisms will not be covered in this program.

The rockets will be fired into altitudes and attitudes designed to simulate the positions of early warning satellites so that what the rockets' instruments will see looking down at the earth will correspond, as nearly as possible, with what the satellite actually would view.

Rocket firings will take place at varied times to enable radiation data to be obtained under different conditions of cloud cover, natural occurrences and night sky.

Launchings are scheduled to take place from the Atlantic Missile Range at Cape Canaveral, from Ft. Churchill, Canada, from a military base in Alaska, from a base in northern Norway and possibly from the Pacific Missile Range and Wallops Island. The final series of rocket launchings will be synchronized with ballistic missile launchings to permit sensing and measuring of infrared and ultraviolet emissions from actual missile exhaust flames.

This program will satisfy a need for an extensive measurement of radiation throughout these wavelengths over the northern latitudes of the United States which would be similar to those expected over the Soviet Union. The measurement program is expected to provide actual data on peak detectivity (intensity of radiation versus intens-



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ity of background radiation) of a missile booster.

Final results of the program, formally known as vertical probe measurement program, will be fed into the planning for the various ballistic missile warning and surveillance systems. The wavelengths to be investigated are broader than those selected for use in the Midas missile defense alarm system, now in early development. But the wavelength presumably more closely approximates those under consideration in a later generation system, first known as Project Lofter, now designated by its ARPA number, 162-61 (AW Apr. 3, p. 33).

Investigation of ultraviolet wavelengths is further evidence of a growing interest in using ultraviolet to augment infrared sensing. In the ARPA 162-61 program, which envisages a satellite warning system more sophisticated than Midas, embodying both defensive and offensive capabilities, infrared and ultraviolet detectors would combine to broaden the detection capability of the system. ARPA 162-61 remains in the thinking stage, although at least five study contracts were scheduled to be awarded by the Air Force's Aeronautical Systems Division (AW Apr. 3, p. 33). The results of ARPA's current program with Naval Ordnance Test Station (NOTS) might well determine some of the sensing parameters of the projected ARPA 162-61 program.

Program Tasks

The program will proceed in three tasks as follows:

- **Task I**—Electromagnetic Radiation Background Measurement Program—This task is expected to require six shots; would involve, as its name suggests, measurements of electromagnetic emissions from the earth in the infrared and ultraviolet spectral regions on densely clouded as well as clear days.
- **Task II**—Auroral Radiation Measurement Program—Three shots are planned to measure characteristic emissions from natural disturbances such as auroras, those luminous displays which occur in their greatest frequency in the northernmost latitudes of the Northern Hemisphere. Ultraviolet spectrum auroral coverage from an extra-atmospheric rocket may prove to be a pioneer basic research effort.
- **Task III**—Boost Phase Radiation Measurement—Eight separate instrumented rocket launchings probably from Cape Canaveral and timed to coincide with ballistic missile launchings will measure the electromagnetic signature characteristics of earth-launched vehicles, probably of IRBM and larger classes.

Hence, analyses of data gathered during the three tasks may answer questions about which are the high inten-

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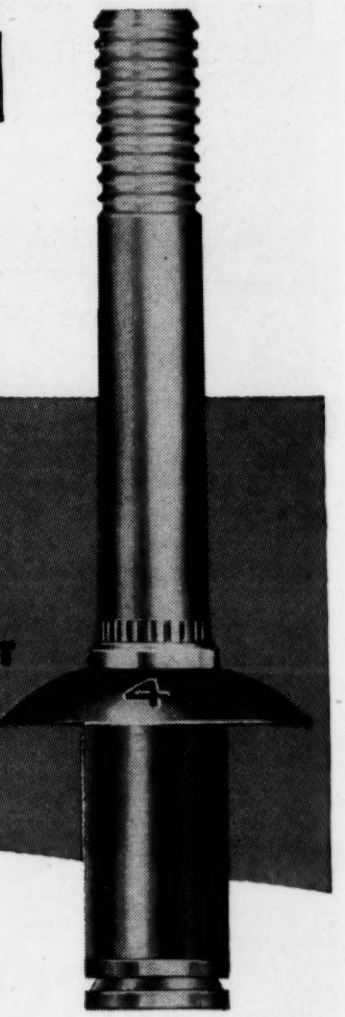

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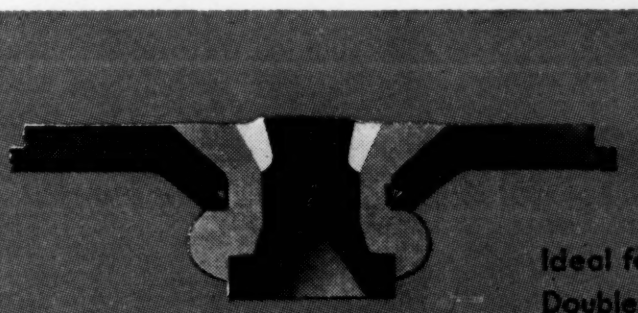

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sity ultraviolet and infrared emitting wavelengths from a missile during its powered phase, which of these are common to or similar to emissions from other earth phenomena, which wavelengths may be expected to be masked out by night sky or natural disturbances.

Each Aerobee or Astrobee rocket will carry a payload in excess of 100 lb. of instrumentation to an apogee between 120 and 130 mi. Most of the instruments will operate for a greater than 4 min. period– starting during the rocket's ascent (at 75-mi. altitude) and continuing through the initial period of its descent (down to 75-mi. altitude).

Detecting equipment will consist of less than a dozen radiometers–some containing multiple cells–and capable of sensing emissions in selected bandwidths. These data will be telemetered back to ground stations although several channels of data will also be recorded in the rocket. This will give scientists a chance, should anticipated air or sea recovery of the rocket payloads be successful, of checking the validity of telemetered data by comparing transmitted with the recorded and stored data.

In addition to the radiometers, each payload will carry at least one camera to guarantee a visual check of what the radiometers are viewing. Other equipment in the payload will include timing devices, telemetry transmitters, and transducers for obtaining thermal and environmental data.

The program will tap diverse talents from several widely scattered organizations. Personnel from National Aeronautics and Space Administration's Goddard Space Flight Center will be consultants as will be scientists at the University of Michigan, who have a wealth of experience and knowledge in the infrared area. Other scientists from the University of Chicago's Midway Laboratories, currently consultants to ARPA, will assist in the project.

Ultimately, NOTS expects to see a follow-on program calling for instrumenting a satellite to take the same measurements as planned in the program. The current program, however, offers an opportunity for testing all equipment in a relatively inexpensive and recoverable rocket.

In some respects this project's objective of determining the signature characteristics of IRBMs and ICBMs parallels portions of Project Press–Pacific Range Electromagnetic Signature Studies (AW Apr. 17, p. 69)–with at least one significant difference. Project Press, interrelated with the Nike Zeus anti-missile missile program, is concerned with ballistic missile signature on re-entry into the earth's atmosphere whereas the measurement program interest would center on the missile during its boost, or powered phase. Both programs are funded through ARPA's Project Defender–the over-all program of defense against ballistic missiles.

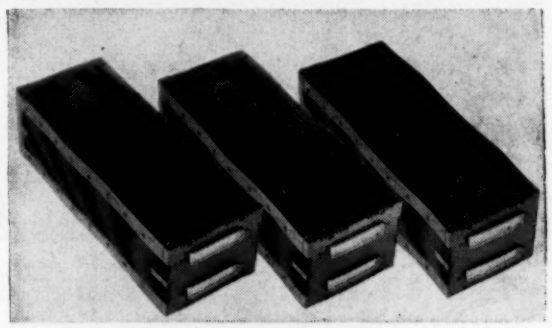
Machine Translation Technique Developed

Washington–Translation of an article from the Russian newspaper Pravda into fully readable English and German on an IBM 7090 computer, with no human intervention or subsequent polishing, at a speed of 60,000 words per hour was demonstrated here recently by Machine Translation, Inc., of Washington, D. C. (AW July 3, p. 33). This is approximately 150 times the speed of a skilled human translater.

Translation speeds of more than 150,000 words per hour are expected to be realized within a year, and speeds up to one million words per hour may be possible using larger computers such as the IBM Stretch, according to Mrs. Ariadne Lukjanow, president of Machine Translation, Inc. Mrs. Lukjanow, who was born in Russia and has a background in mathematics and physics, has been working on automatic machine translation for about four years.

At these speeds, it should be possible to provide rapid translation of all important foreign newspapers and scientific papers, possibly from one or two automatic translation centers, Mrs. Lukjanow predicted.

Although U. S., Soviet and other foreign scientists have been working for several years on machine translation, and have demonstrated word-for-word conversion from one language to another, the new system is believed to be the first to translate on the basis of the context in which the word is used. The machine can select the most appropriate word from up to 25 different possible meanings, Mrs. Lukjanow says.



PCM Telemetry

Airborne pulse-code modulation (PCM) telemetry system, providing 48 channels, occupies only 250 cu. in., weighs less than 14 lb. System, consisting of a Model 203 multiplexer, Model 205 programmer and Model 127 digitizer, employs all silicon solid-state circuitry and welded construction. Manufacturer: Electro-Mechanical Research, Inc., Sarasota, Fla.

FILTER CENTER

▶**RAAF to Use French Radar**—Royal Australian Air Force Mirage III interceptors will be equipped with the same Cyrano fire control radar used in the French air force Mirage III aircraft rather than British-built systems. Radar is built by CSF-Compagnie Generale de Telegraphie Sans Fils.

▶**RCA to Develop DME-T**—Radio Corporation of America will join Collins Radio and Federal Electric as suppliers of Tacan-compatible distance-measuring equipment. RCA expects to have its prototype DME-T equipment ready for evaluation by interested airlines by early 1962, with production equipment available during the summer of 1962. Company will make extensive use of transistors in its new DME-T as well as latest techniques in channel switching.

▶**Japan Discloses Molectronics Activity**—Mitsubishi Electric Mfg. recently disclosed that it has developed 11 types of basic molecular electronic circuits, similar to those developed by Westinghouse, which it expects to market soon. Molectronic circuits developed by the Japanese firm to date include: audio preamplifier, 3-watt power amplifier, sine wave tuned oscillator, phase-shift oscillator, notch filter, saw-tooth oscillator, horizontal TV trigger circuit, multivibrator, OR circuit for computer use, multi-contact switch, diode matrix.

▶**Ceramics for MHD Power**—An experimental magnetohydrodynamic (MHD) generator, which uses ceramic electrodes and thermal insulators, has been operated continuously for up to 50 min., compared with usual operating periods of only a few seconds, Westinghouse Electric says. In the MHD generator which employs a moving stream of ionized conducting gas at temperatures as high as 5,000F, electric power is produced as the plasma moves past pairs of electrodes. Westinghouse is experimenting with zirconium oxide and magnesium oxide as an insulator for the generator walls, and with refractory metals such as tungsten, tantalum and zirconium, in various alloys and compounds, for use as electrodes.

▶**Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include:

• **Texas Instruments, Inc.,** Dallas, $268,000 contract to develop an unattended seismic monitoring system as part of Vela Uniform program to develop improved means for detecting underground nuclear explosions. Contract is under the technical direction of Air Force Cambridge Research Laboratories.

• **General Precision's GPL Division,** Pleasantville, N. Y., $1.1 million Air Force contract to modify Radan doppler navigation equipment used on earlier model B-52s.

• **Radiation, Inc.,** Melbourne, Fla., $379,000 award for satellite microwave beacon transmitters and special receivers for wide-band radio transmission experiments, from Cornell Aeronautical Laboratory for use in Air Force-sponsored propagation experiments.

• **Cubic Corp.,** San Diego, will build transponders for USAF Samos reconnaissance satellite, under contract from General Electric's Missile and Space Vehicle Dept. The six-pound UHF transponder will be used to establish precise satellite orbit information.

• **General Telephone & Electronics,** Sylvania Div., Waltham, Mass., $1.2 million contract extension from Army for ground stations to be built at Fort Dix, N. J., and Camp Roberts, Calif., for use with Advent communications satellite.

• **Epsco, Inc.,** Cambridge, Mass., $360,000 contract for design and manufacture of three pulse-code modulation telemetry receiving stations, from Goddard Space Flight Center of National Aeronautics and Space Administration.

• **Western Electric Co.,** $19.1 million from Army for work on UniCom universal integrated communications system, covering fabrication of engineering test network.

• **Canadian Marconi Co.,** Montreal, $1.5 million Air Force order for airborne doppler navigation systems.

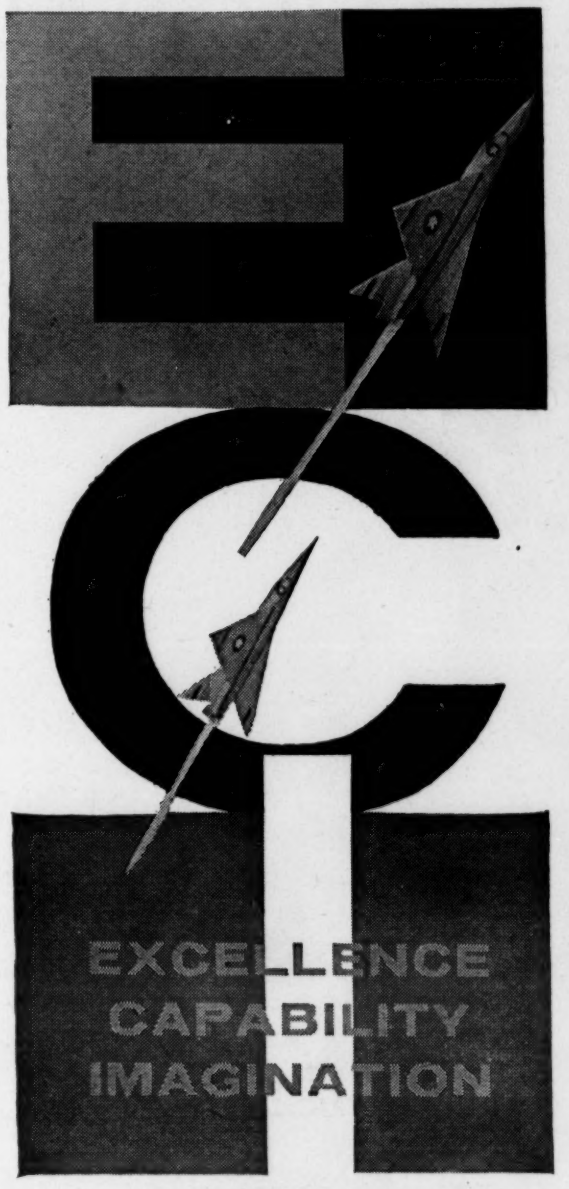
• **Texas Instruments, Inc.,** Dallas, $1 million contract from Bureau of Naval Weapons for AN/APS-88 airborne radar for use on S2F-3 aircraft. Radar can be used to display airborne targets, sonobuoy beacon and IFF beacon replies as well as for weather surveillance.

• **Minneapolis-Honeywell,** Special Systems Division, Pottstown, Pa., $7 million contract from General Dynamics to produce ground support equipment for Atlas series "F" missiles. Equipment includes pressurization control, pneumatic distribution and helium control charge units.

• **Maxson Electronics Corp.,** New York, contract from USAF to develop lightweight portable Tacan ground transmitter.

• **California Eastern Aviation, Inc.,** Washington D. C., $600,000 contract from Boeing for undisclosed airborne countermeasures device to be used on B-52H.

• **Emertron, Inc.,** Jersey City, N. J., $723,000 award from Bureau of Naval Weapons for development of new airborne countermeasures systems.



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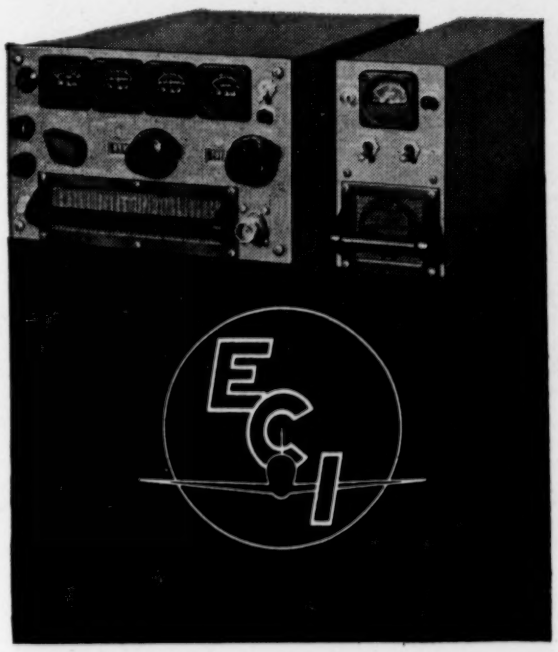
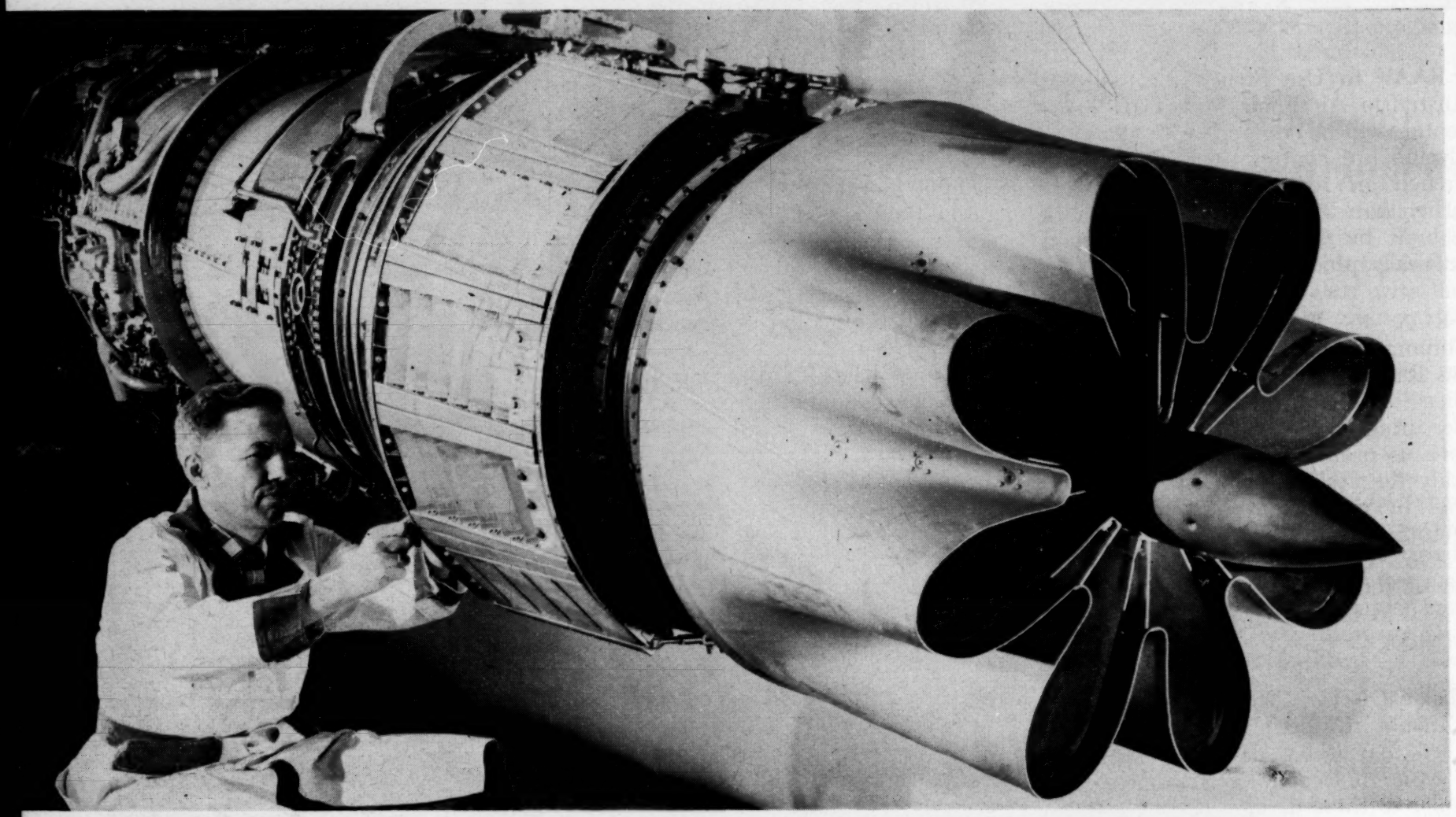
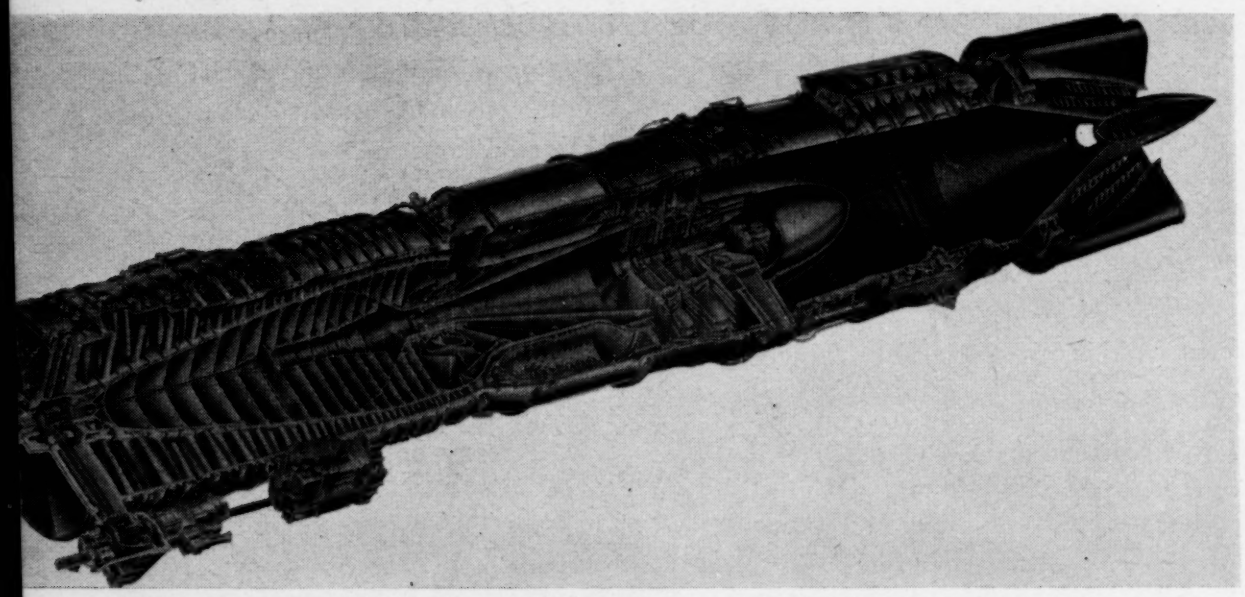


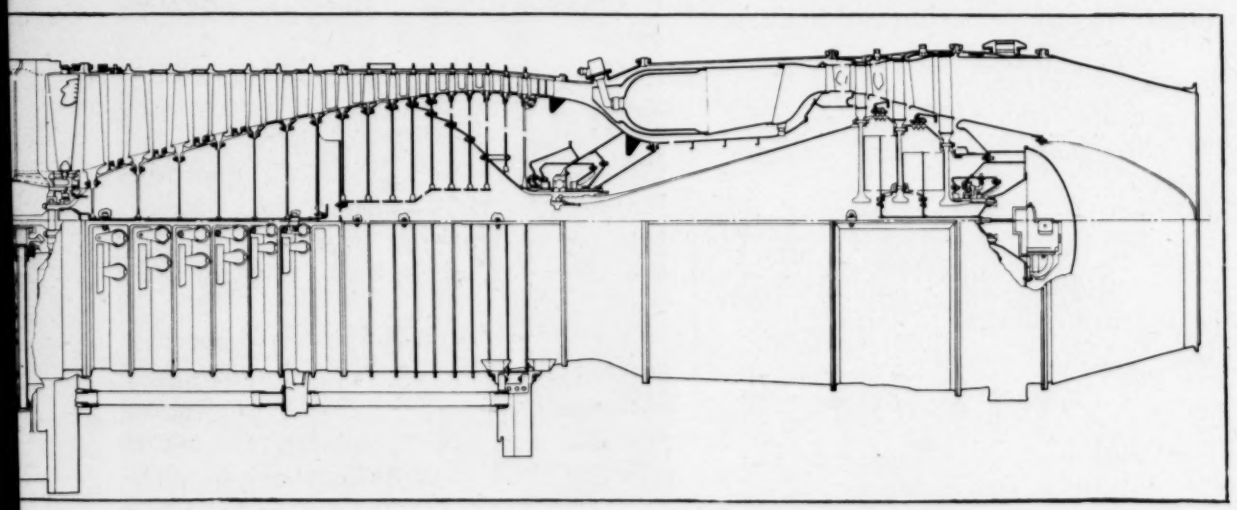


GENERAL ELECTRIC CJ805-23 aft fan turbojet with thrust reverser is shown on the factory floor at Schenectady plant.

Air Carriers Gain CJ805-3 Experience



LINE AND CUTAWAY views of General Electric CJ805-3 straight jet.



By David A. Anderton

Evendale, Ohio—General Electric CJ805-3 turbojet, now believed over the initial hurdles of mechanical and performance problems, is racking up time at the rate of 25,000 hr. per month in the fleets of Delta Air Lines, Trans World Airlines, and Northeast Airlines.

Operators are reporting about six hours per day utilization of the single-spool powerplant. Premature engine removal rate is stabilizing at about 0.3 per 1,000 hr. In-flight engine shut-down for any cause was 0.065 per 1,000 hr. at the end of April, 1961, last month for which data currently are available.

Crossover Point

On June 30, total engine time was 161,000 hr., a figure approaching that of all the military time accumulated since its antecedent, the J79, first flew in December, 1955. Crossover point between military and commercial flight time was expected to occur this month.

Engines are currently approved for 1,200 hr. time between overhauls (TBO) in Delta service, where they have been operating since May 16, 1960. They entered service at 800 hr. TBO, were approved for 1,000 hr. last

December and for the current mark Apr. 17, 1961. Controls and accessories now carry a 1,500-hr. TBO in Delta service.

TWA and Northeast are now operating engines with 1,000-hr. TBO, since they were only introduced to their fleets in January of this year and started service in May.

Right at the beginning of airline use, fuel consumption was higher than the operator expected. Both engine and airplane were at fault: the drag of the Convair 880 was higher than estimated, and so was the specific fuel consumption of the GE CJ805-3 engine.

For the engine, the difference was 3% over guarantee or 6% over estimates, when the airplane was cruised at Mach 0.84 and 35,000 ft., the original flight plans for Delta and TWA. Engines being shipped were meeting guarantees, based on sea-level static points, but the altitude performance was off.

Two basic sets of fixes were developed by GE for the engine problem. First of these was aimed at reducing the exhaust gas temperature without reducing specification thrust. This was done by opening the suppressor nozzle area to drop the temperature. This normally would reduce thrust as well as the specific fuel consumption, but by opening the variable stator ¾ deg., the engine pumped additional air mass, compensating for the loss in thrust caused by temperature drop.

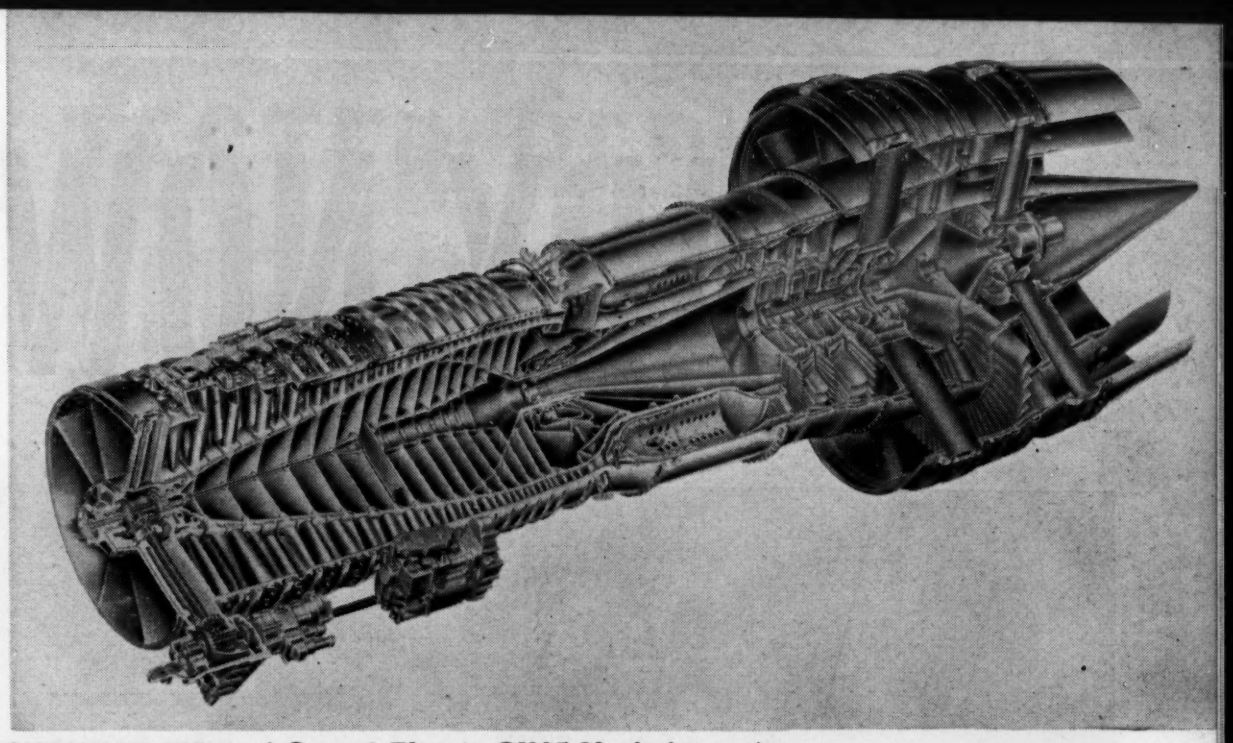
This change improved the altitude performance and also permitted pulling more thrust on a hot day. Now flying on both TWA and Delta aircraft, the change—plus capping off the combustion and turbine case drains to eliminate gas leakage overboard—has dropped the specific fuel consumption to the guaranteed figures.

Delta says this first change dropped its fuel consumption by 1,200 lb. per hour.

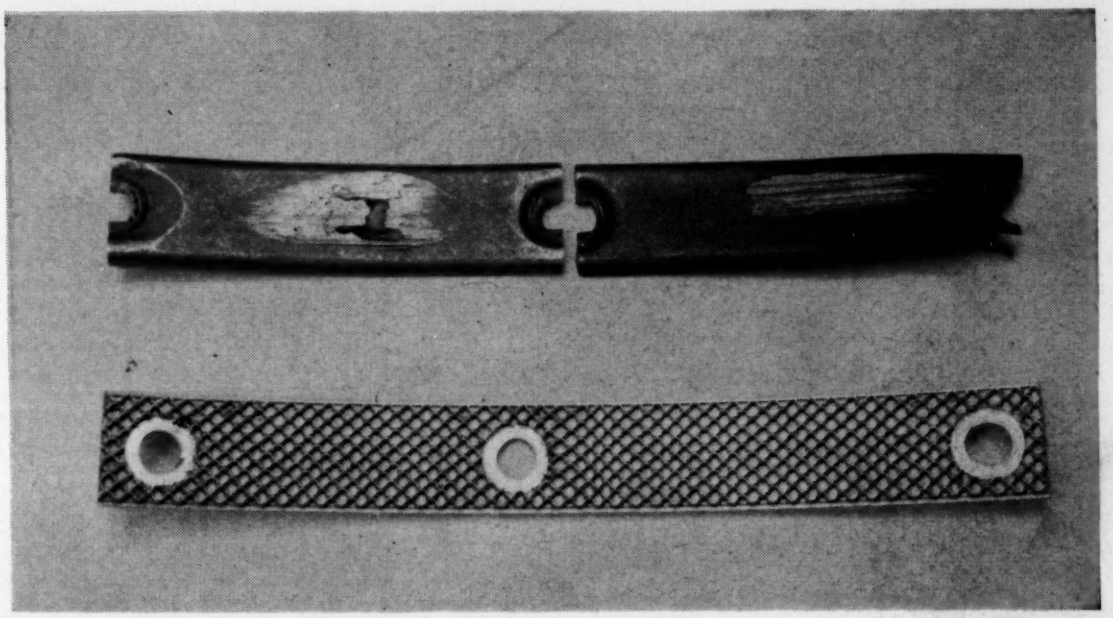
A second set of changes, now in the works and expected to go on delivered engines in September, will re-schedule the variable stator program as a function of engine speed, and optimize that relationship. This change improves compressor efficiency at a given thrust and also lowers the operating temperature. Test flights with this change have been made by Convair, and current schedules call for it to be demonstrated to the Federal Aviation Agency in August on a Delta airplane.

Final result of both changes is expected to drop the specific fuel consumptions below guarantees to the estimated figures. All cost of the engine change program is being borne by GE.

There is one more point that is expected to help in optimizing engine cruise trimming. The original controls for the CJ805 were a departure from conventional and were based on rpm. monitoring. But GE is changing back to the tried-and-true pressure ratio system for future deliveries, because such a system gives more accurate control of the engine performance than did the rpm.-monitoring unit.



CUTAWAY VIEW of General Electric CJ805-23 aft fan engine.



OLD FIRST STAGE TURBINE shroud (top) showing damage and new type shroud.

These were the basic problems in engine performance; they now appear to be completely solved. But shortly after isolating them and starting to work on improving engines to meet guarantees, mechanical problems began to show.

Delta Air Lines, first to use the GE engine on its Convair 880s, was also the first to run into some problems. In July, 1960, about two months after the start of service, airline personnel heard screeching sounds during starts of the powerplants. In some cases, the engines wouldn't start at all.

The trouble was caused by rubbing between the first stage turbine blades and their shroud, a 20-segment assembly bolted to the frame between segments so that half the bolt-hole was in one segment and half in the adjacent piece. Under thermal stresses, the shroud pieces would tilt in, and rub against the turbine blades. At best there was simple interference, with bucket metal being scrubbed on the inside of the shroud. At worst, the segments were rubbed so hard they tended to straighten out, and to pull out of the frame and fall into the turbine, jamming it and preventing rotation.

The trouble began at about the 400- to 500-hr. total time point on the engines. By setting a tough accelerated test program schedule, GE engineers were able to produce the same troubles in about 50 hr. time. The schedule called for half time at takeoff power, and the other half split among steady accelerations from idle to takeoff, interspersed with bursts of power.

The fix was a material and design change. From 20, the number of segments was reduced to 10, each fastened with three bolts. The solid Inconel shroud segments were changed to a honeycomb assembly, with Hastelloy X replacing the Inconel material on the inner face.

This design is like that used on second-and-third-stage turbine shrouds, but wasn't specified at the time the engine was laid out. Then, honeycomb technology wasn't advanced enough to guarantee bonding integrity at the operating

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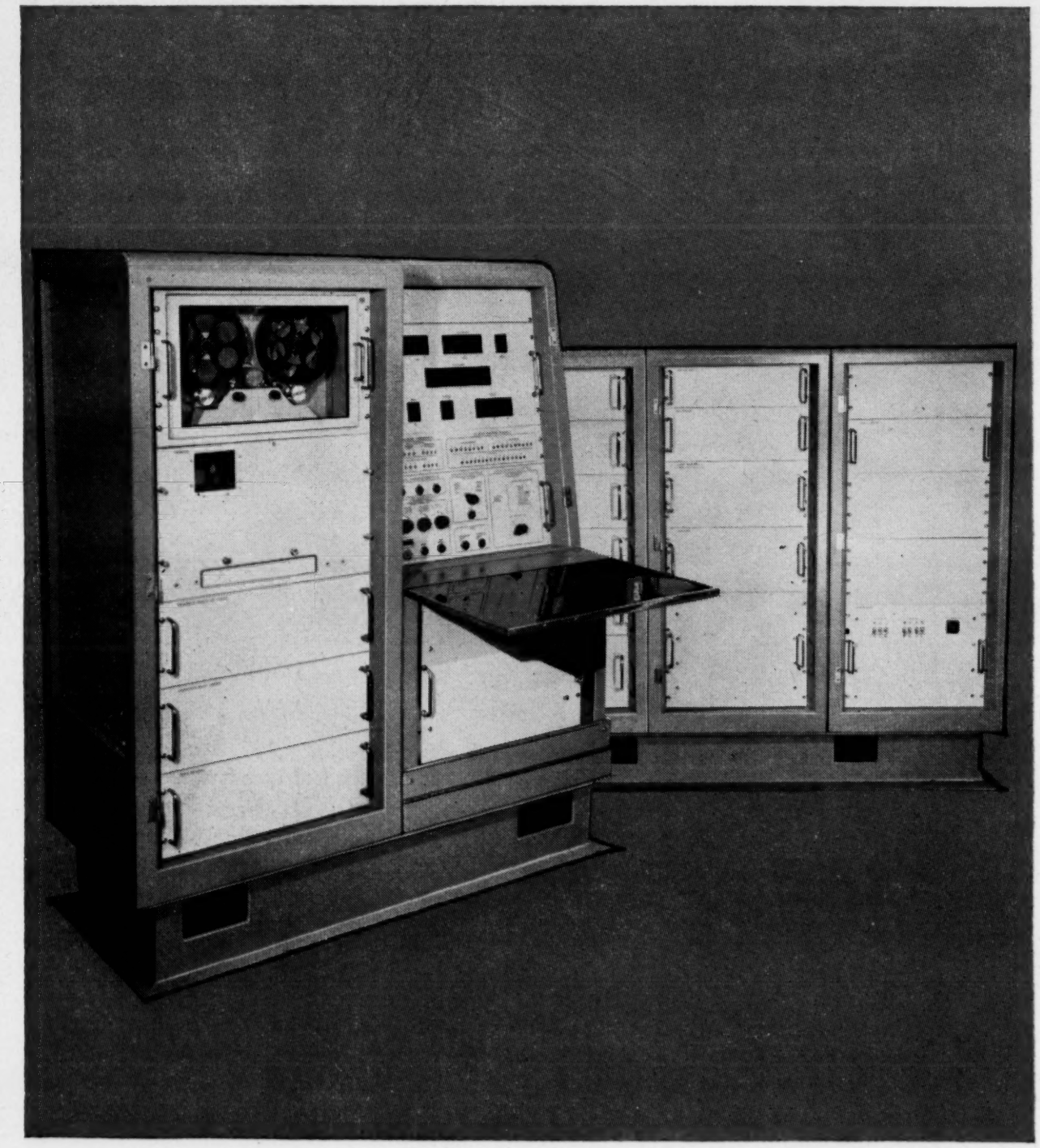

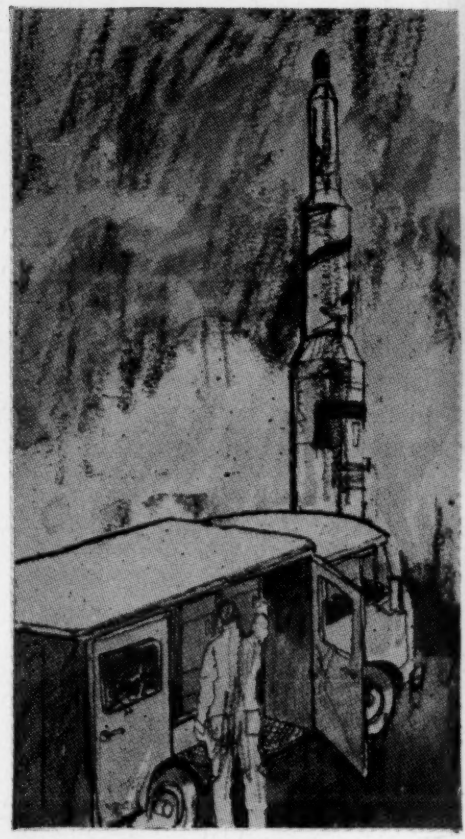

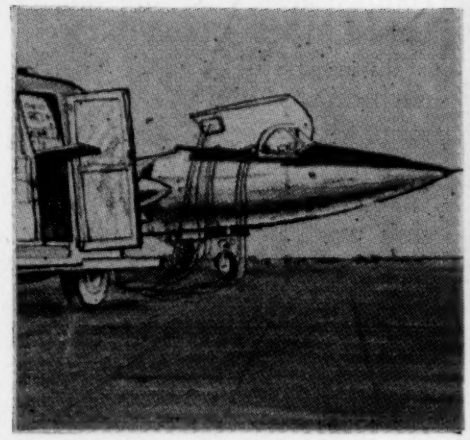

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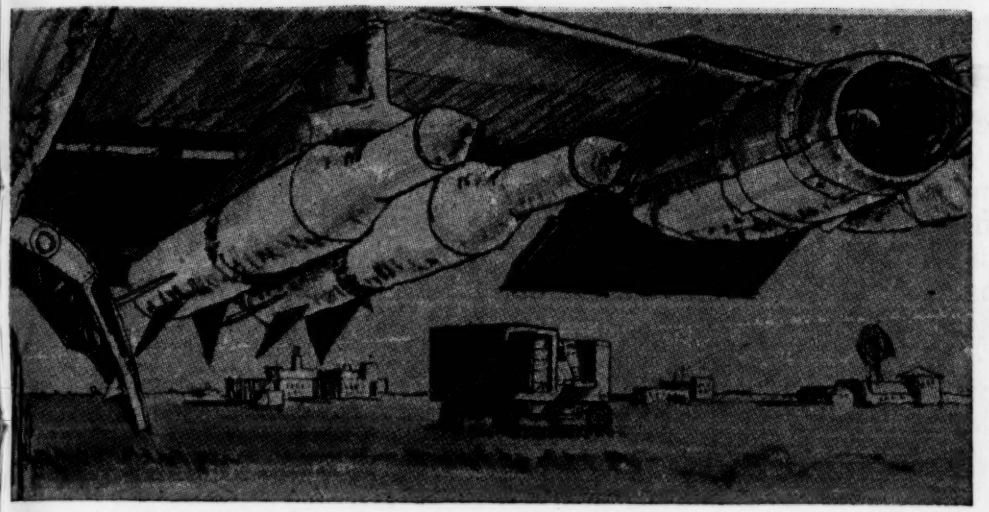

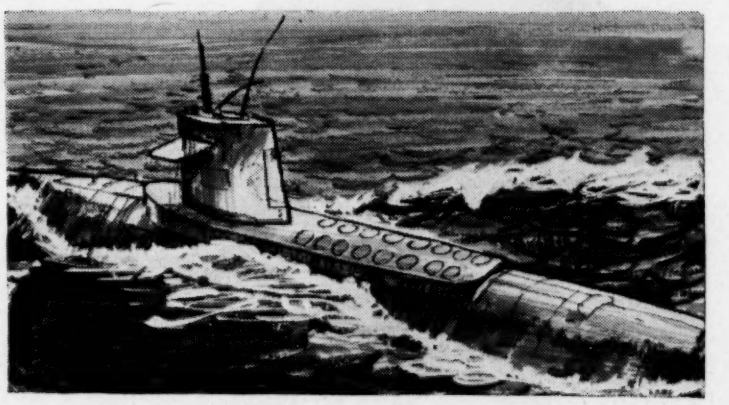

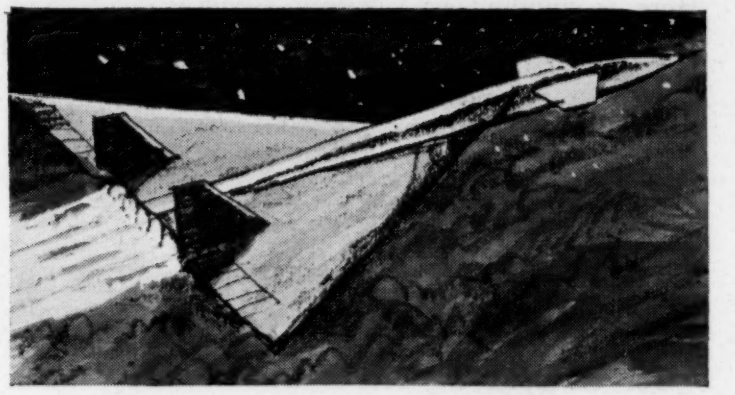

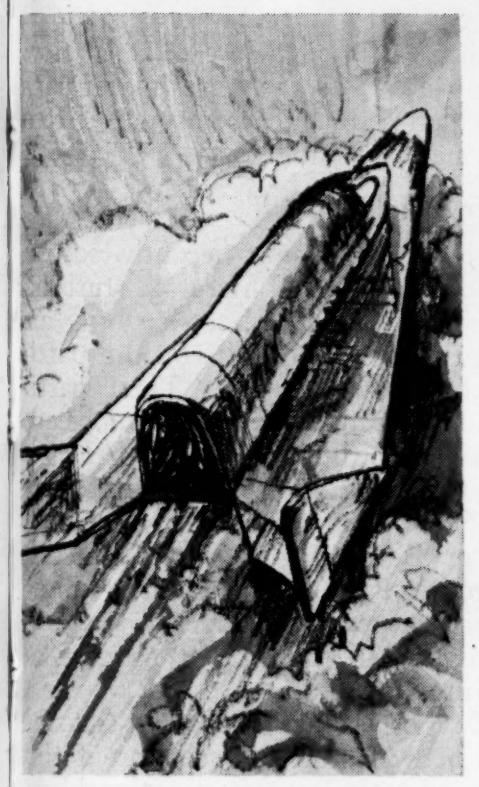

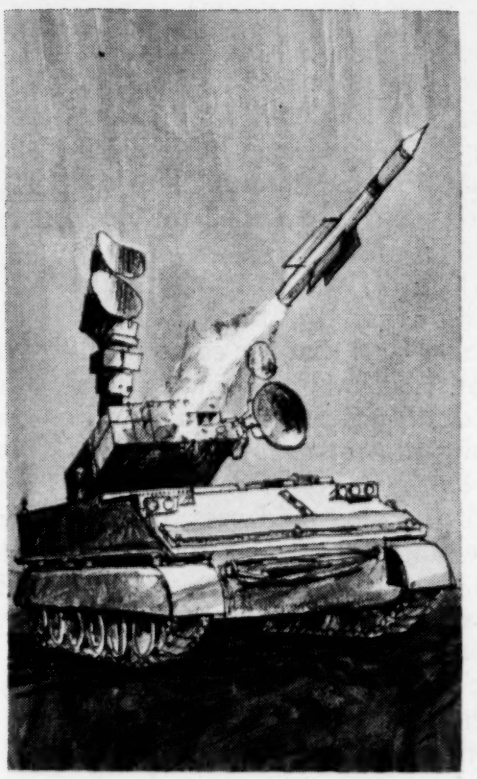

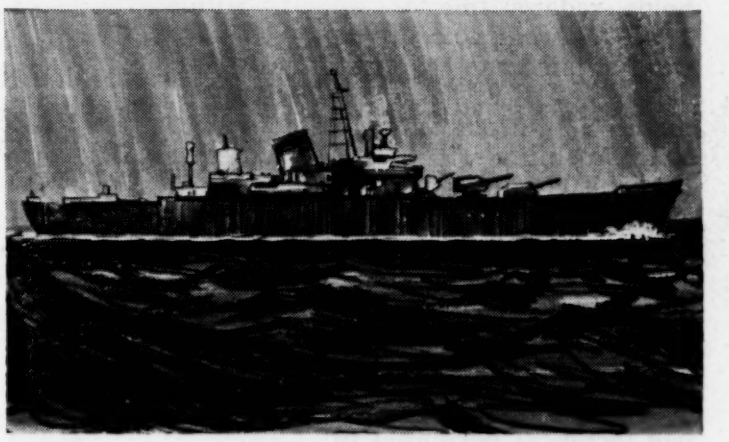

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The first application is the USAF's Douglas-built Skybolt Missile. Built to Mil-P-26664A, and designated AN/GJQ-9 by the USAF, the Universal Programmer-Comparator is available as Model PC-300 for commercial applications.

This Universal Tester is the latest Bendix achievement in the Support Equipment field and is another example of the engineering and production skills we have developed over a period of forty years. Whether the need is military or commercial, Bendix can provide the answer that does the job *best.*

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For example, the MK 73 shipboard guided missile fire control director holds radar's line of sight to within 1/350°. Similar precision capabilities were applied to the MPQ-4 mortar locator, the Atlas Guidance Tracker, and the FPS-7 search antenna. This precision capability will also be applied to the SPS-30 antenna, and the three-axis satellite communications antenna for the Advent Program—the Department's first entry into space applications.

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167-03

GENERAL ELECTRIC

temperatures of the first turbine stage. But progress with the celled structure has made possible the use of honeycomb in hotter areas and GE was able to make the design change.

The same kind of accelerated test was run on the new shroud, and at 150 hr., inspection showed no rubbing. The tests were increased to 300 hr.—corresponding to several thousand hours of normal running—and the honeycomb stayed intact.

Carbon Ball Blasting

But the honeycomb wasn't immune to erosion caused by carbon balls blasted loose from the combustion chamber dome. These chunks of carbon would form during running, pull loose and hit the leading edge of the first-stage turbine buckets. This caused some local erosion.

Centrifugal force in the turbine next threw the carbon against the shroud and eroded it. The carbon chunks, ground fairly fine by this time, continued downstream and hit the second-stage turbine stators near the shroud. The impact cut slits in the blades near their intersection with the shrouds.

The first fix was to build up the intersection of the second-stage turbine stator blades with their shroud. This was done with a plasma spray of hard Coast Metal 50.

But the real fix was to eliminate the carbon build-up in the first place. Investigation showed that the carbon balls built up at a backward louver, an aerodynamic dead-spot in the dome. By slotting out the upstream end of this louver, it could be transformed into an arch which the air would pass through, cleanly wiping off any carbon that tended to accumulate.

This fix is being made by airlines during routine maintenance on the engine. The tool is a simple one, and so is the operation.

Two third-stage turbine buckets failed, for no apparent reason and without any similarity in the failures. Engineers ran test engines through all possible regimes and couldn't duplicate the failures. So they took new blades, and put them through high-temperature fatigue tests. In a very short time, the blades failed, and the engineers had their clues.

They found that the finishing processes were building-in residual stresses at random locations on random blades. The solution was to work with the airlines, pulling blades and re-heat-treating them to even out the stresses. This fixed the troubles, which had happened twice again during the fix program for a total of four turbine-blade failures. All new blades are normalized after finishing as standard procedure now.

A long chain of events led to troubles with the front bearing, showing up in four cases of spalling. The trail led back through the bearing, misalignment at the hub and distortion of the front frame from the engine anti-icing system.

This system has automatic sensing that actuates the anti-icing when accretion of ice has occured. The airplane and engine ice-sensing system is Convair's, but there are also some GE parts. Somewhere along the circuitry, either the sensing system or the GE valve that was actuated by the sensors responded to faults, and operated the anti-icing system.

When this happened on a hot day, the high thermal gradients in the front frame distorted it, because there was no ice to melt off and no place for the added heat input to go. The frame distortion caused proportionate distortion in the bearing hub, and the misaligned bearing spalled.

Convair, the airline users and General Electric all made portions of the fix. The first two cleaned up that part of the airplane electrical system and changed to manual instead of automatic actuation of the anti-icing system.

General Electric developed a new control valve, and a new method of control which sensed temperature. There has been no trouble since.

Other Problems

One problem most recently solved cropped up in the first-stage turbine nozzle diaphragm, where cooling air passages became blocked and the partitions burned as a result. These partitions have been repaired or replaced, depending on the extent of the damage. But starting July 1, new parts were available which featured better handling of the cooling air, and a material change to Rene 41, a General Electric high-temperature alloy.

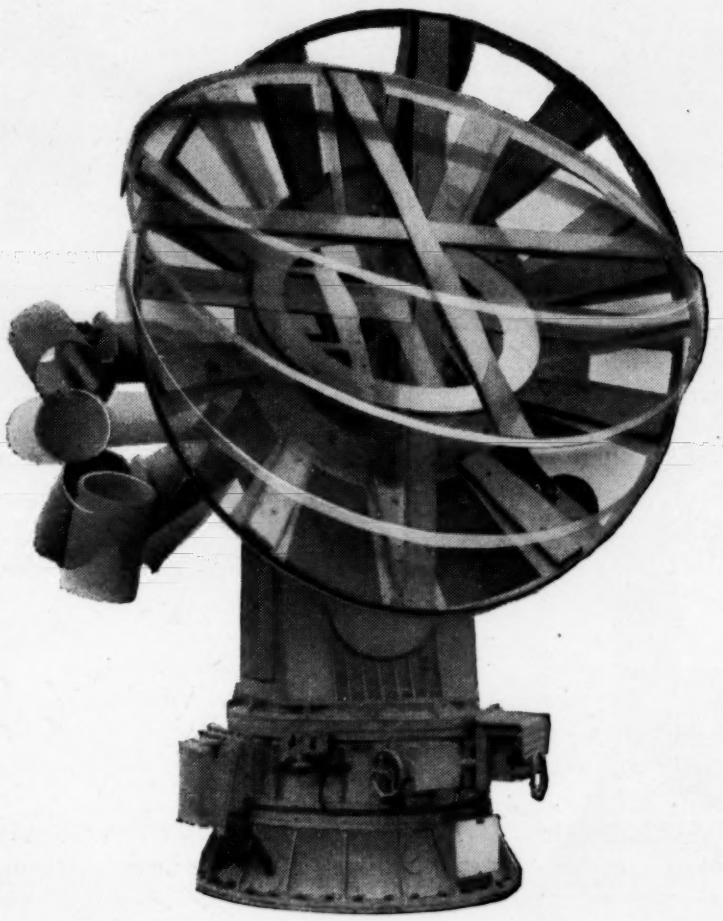
This fix will be made at no cost to the airline operators.

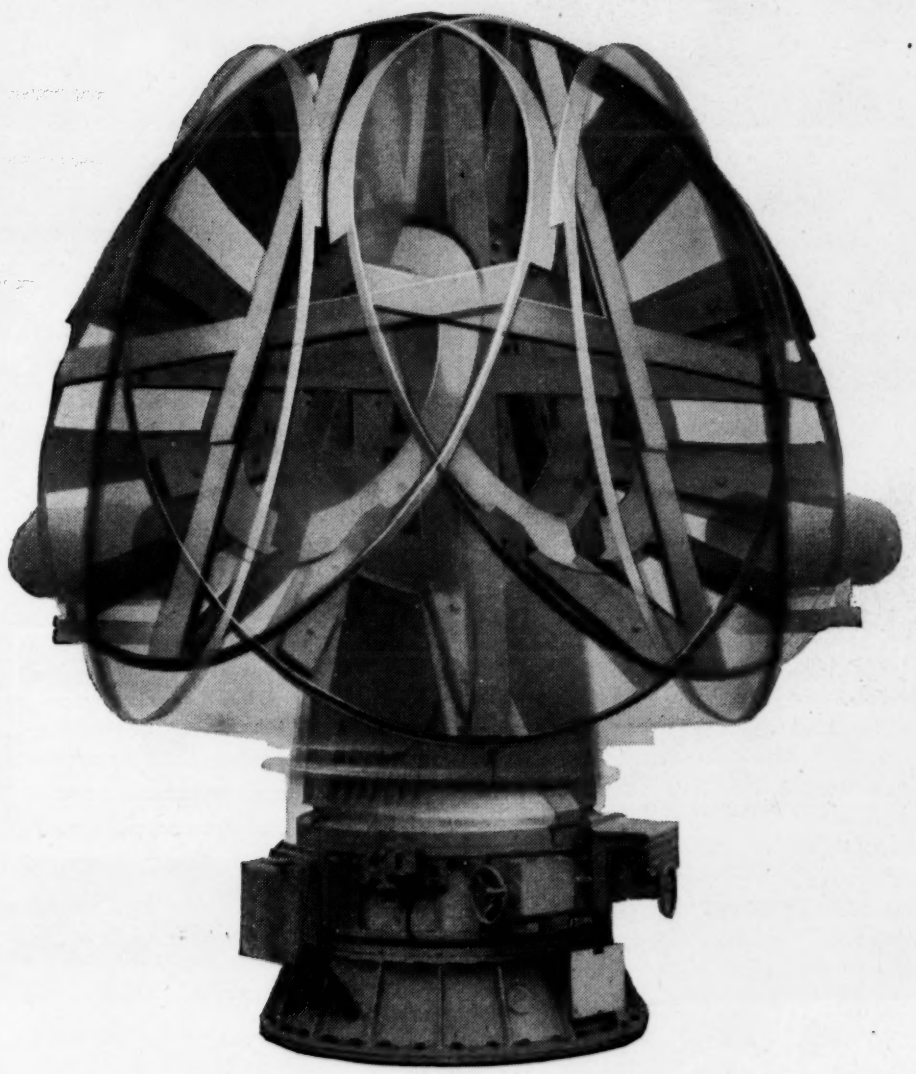
GE reports some leakage and transfer of oil between the two sections of the engine oil tank, but this minor problem has been fixed by quality control. The company also says that thrust reversers furnished for the engines have shown some localized cracking, but nothing that should be a repeating or unusual problem. There also has been some fretting on the ledges where the stator blades fit into their ring assembly, but plating of the blades has fixed that.

So far, there have been few engines removed for foreign object damage—last check showed less than five such engines—and no engines prematurely removed have needed overhaul to date, the company says.

Only about 50 to 55 engines have been through overhaul so far, either at Delta's workshops, or at one of the two GE overhaul facilities. Scrapped parts cost is currently running between $8 and $10 per hour of running time.

PRECISION TRACKING





HOLDS RADAR'S LINE-OF-SIGHT TO WITHIN 1/350°

Even when subjected to repeated ±30-degree rolls in a 9-second period, the shipboard Guided Missile Fire Control Director MK 73 accurately stabilizes the radar beam of the Navy's Tartar Weapon System to within 1/350 of a degree.

The MK 73 precisely controls the radar's automatic target acquisition, provides accurate target position data, and instantly locks-on to supersonic, highly maneuverable targets.

Unique, gearless power drives developed by the Ordnance Department are major contributors to making the MK 73 the smoothest sea-borne tracker known. The constant-speed control of these power drives is accurate to within 1% at speeds as low as 3 milliradians per second and the percentage of error decreases with increased speeds.

Accuracy such as this is typical of the precision which is designed and manufactured into antennas, fire control, inertial guidance, launching and handling equipment, and torpedoes by General Electric's Ordnance Department. 166-24

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The Kinetics' motor-driven switch features extremely low contact resistance. If arcing should occur, the arc is drawn away from the mating parts of the contacts. As a result, there is little or no change in internal resistance during the life of the switch.

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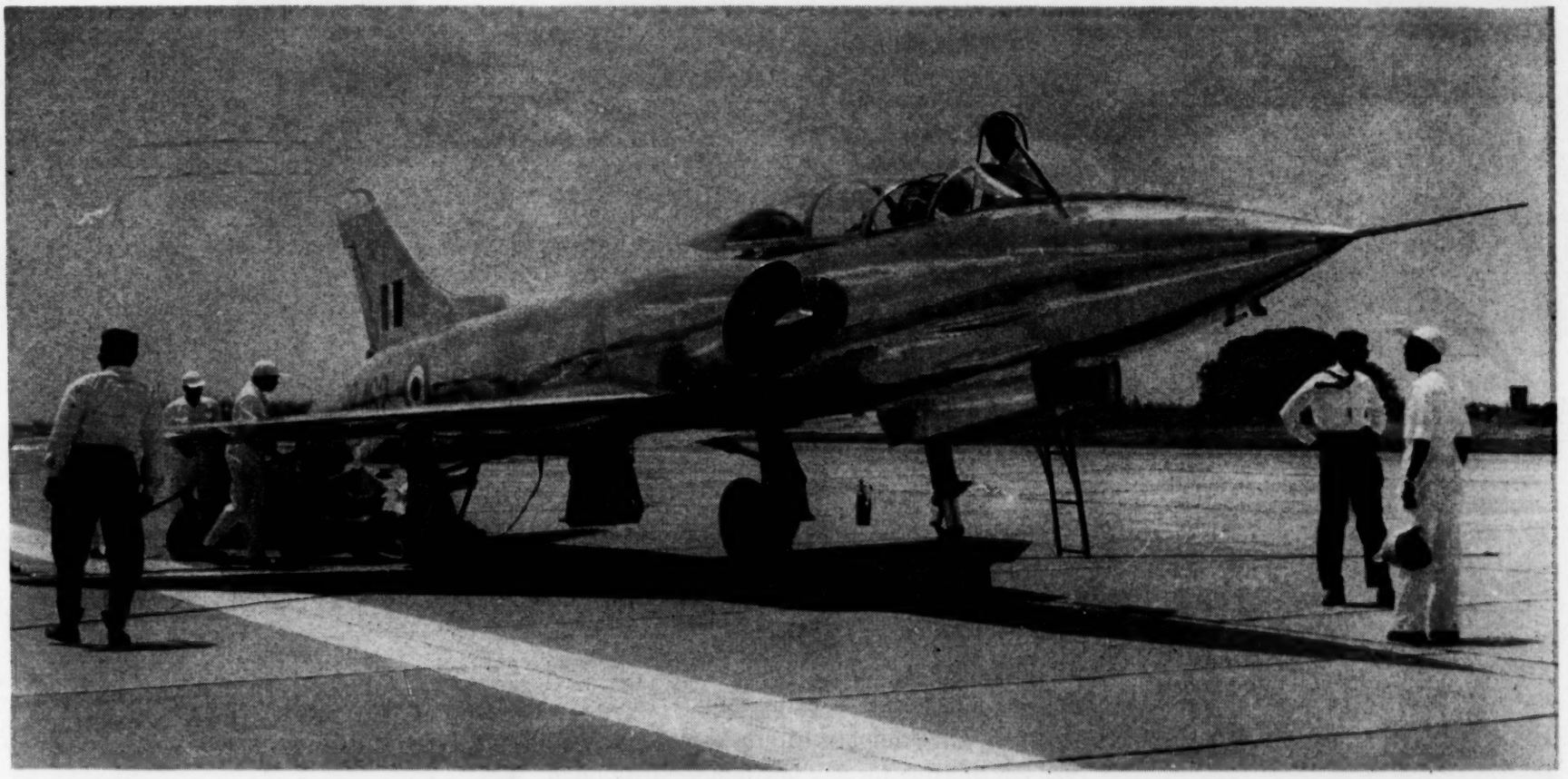
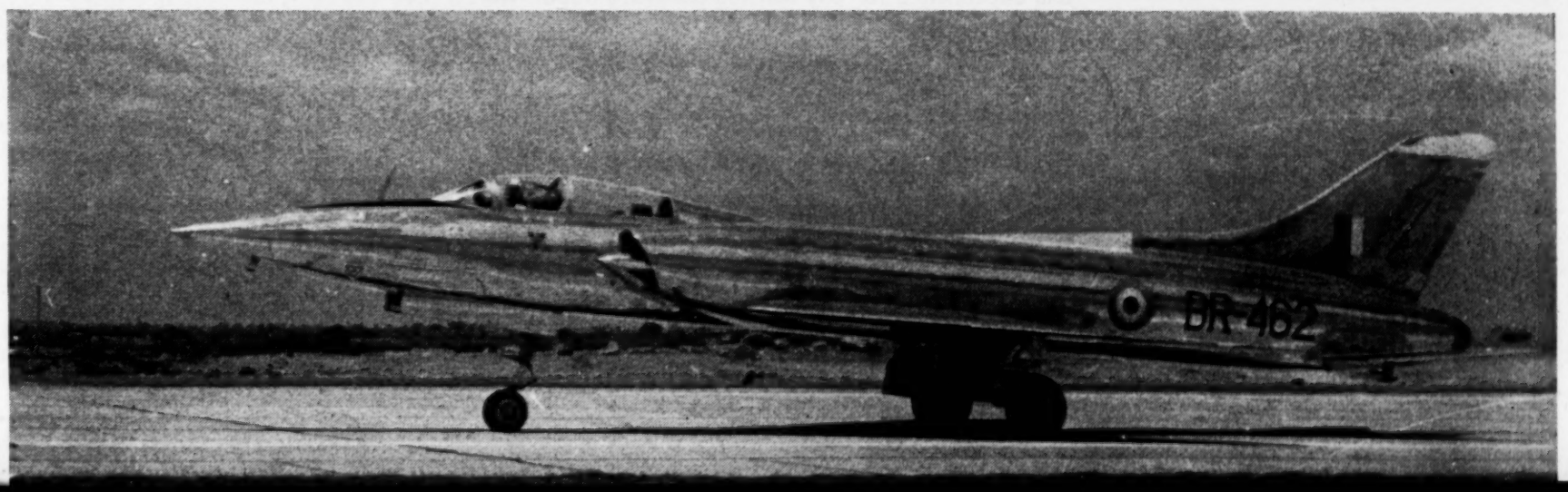
Indians Test HF-24 Supersonic Jet Fighter

First supersonic aircraft designed exclusively in India, the Hindustan Fighter 24, is shown in an early test flight (above). Manufactured by the Hindustan Aircraft Factory, the plane is powered by two Orpheus 2 engines but ultimately will be powered by more powerful Orpheus 12s, developing 6,810 lb. thrust. Aircraft is designed to be equipped with air-to-air guided missiles. First production model is expected within a year. Indian air force will get priority on deliveries but India also plans to sell the planes to neighboring nations.





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USAF Contracts

Following is a list of unclassified contracts for $25,000 and over as released by U. S. Air Force contracting offices:

HEADQUARTERS, AIR FORCE MISSILE TEST CENTER, AIR FORCE SYSTEMS COMMAND, USAF, Patrick Air Force Base, Fla.

Kynatronics, Inc., Orlando, Fla., modification of TLM-18 antenna system PR 61-1072, contract AF 08(606)4515, April 14, 1961, $306,366.

Milgo Electronics Corp., Miami, Fla., plotting boards, 3 each PR 61-1088 (IFB 08-606-61-125), contract AF 08(606)4629, April 18, 1961, $41,218.

Instrument Corp. of Florida, Melbourne, Fla., mobile ballistic camera system, PR 61-1102, contract AF 08(606)4611, April 20, 1961, $365,328.

Scott Steven Builders, Inc., Miami, Fla., paint interior surfaces of building 313, 800, 545, 430, 576, 310, and 989, PR 61-11649, (IF 08-606-61-128), contract AF 08(606)-4538, Mar. 27, 1961, $27,750.

Convair Astronautics Division, General Dynamics Corp., San Diego, Calif., repair of storm damage, Azusa Mark II, PR 61-1089, contract AF 08(606)4535, April 21, 1961, $59,950.

Pan American World Airways, Inc., New York, N. Y., increase in funds, PR 61-146, supplemental agreement No. 4 to contract AF 08(606)3413, April 26, 1961, $337,000.

Bunnell Piling Co., Inc., Naples, Fla., emergency repair seawall and fencing PR 61-11662, (IFB 08-606-61-143), contract AF 08(606)4628, April 26, 1961, $28,390.

Remington Rand Univac Division of Sperry Rand Corp., St. Paul, Minn., real time data handling system, PR 61-1028, contract AF 08(606)4455, April 26, 1961, $469,953.

Mamba Engineering Co., Inc., Titusville, Fla., repair runway access taxiway G, PR 61-11664, (IFB 08-606-61-144), contract AF 08(606)4642, April 27, 1961, $25,061.

HEADQUARTERS AIR FORCE FLIGHT TEST CENTER, AIR RESEARCH AND DEVELOPMENT COMMAND, USAF, Edwards Air Force Base, Calif.

Sante Fe Engineers, Inc., Lancaster, Calif., modification of construction of a Lox-Clean Room Facility, $43,984.

McDonald Contractors, Inc., Los Angeles, Calif., modification of rocket engine test stand, $157,425.

Gilmore Industries, Inc., Cleveland, Ohio, V/STOL test stand, nine bidders were solicited, four proposals received. $54,998.

Consolidated Electrodynamics Corp., Pasadena, Calif., oscillograph recorders, one bidder was solicited and one proposal was received, $54,998.

HEADQUARTERS, SACRAMENTO AIR MATERIEL AREA, USAF, McClellan Air Force Base, California.

White's Inc., Brewton, Ala., repair/overhaul generator sets AF 04(606)-8521 IFB 04-606-61-300, $119,146.

North American Aviation, Inc., Los Angeles, Calif., design and development of aircraft modification kits and type VIIIC pylons (letter contract AF 04(606) 8703 RFP SM-1-1560-1475), job est. $815,110.

North American Aviation, Inc., Los Angeles, Calif., design, development and testing of type X launchers and associated GSE (letter contract AF 04(606)-8660 RFP SM-1-1560-1336), job estimated $3,138,150.

HEADQUARTERS, ROME AIR MATERIEL AREA, USAF, Griffiss Air Force Base, N. Y.

Kaiser Aluminum and Chemical Corp., Bristol, R. I., 6154-635-5332 cable, special purpose, electrical, Type WF-14/U, in accord with MIL-E-9088A. Contract AF 30(635)-19979 (RFQ 30-635-61-5139 Q)—300,000 ft. $54,600..

The Bendix Radio Division, Bendix Corp., Baltimore, Md., depot level maintenance services for navigational aid equipment and associated ancillary equipment for USAF

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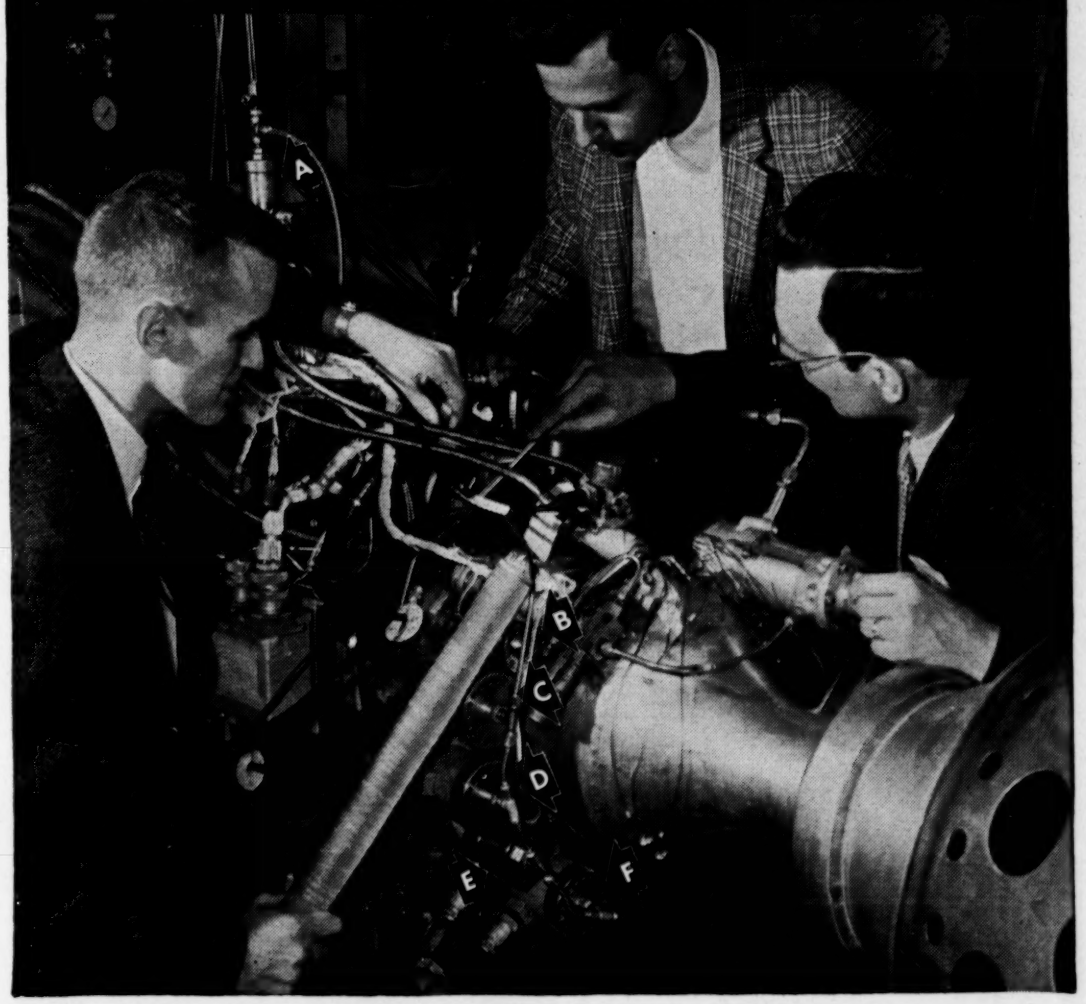
ABOUT TELEDYNE AND TELEFLIGHT PRESSURE SYSTEMS



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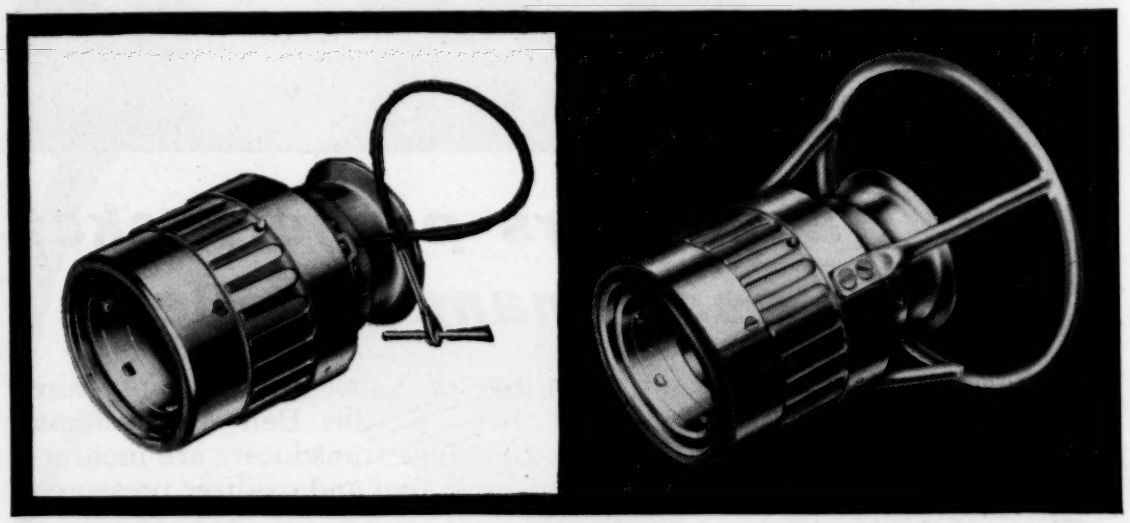

MILITARY AIR-START—Two military types available. One for use with V-band adapters; the other for use with hose-shank adapters.

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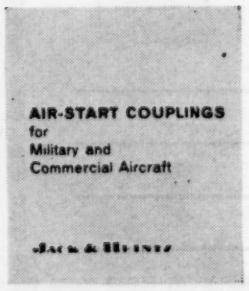

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Central Mobil Depot Activity at OC AMA. Order to contract AF 30(635)-17980 job $75,000.

Pentron Electronics Corp., Chicago, Ill., Components for transmissometer set AN/GMQ-10B in accord with MIL-T-4663 (USAF). Contract AF 30(635)-21461, (IFB 30-635-61-242B), 7 items, $64,998.

Avco Corp., Electronics and Ordnance Division, Cincinnati, Ohio, S/N 5840 NSL (Service Test Model) radome, Type CW-424/FPS-26 in accord with MIL-R-27059 (USAF) Contract AF 30(635)19825, (RFQ30-635-60-4337Q) 1 ea., $152,634.

Winzen Research, Inc., Minneapolis, Minn., 6660-NSL balloon, polyethylene, Model PA-238.5-100-N.S.C.-01, N/A AF 30(635)-21846, (RFP 30 635-61-3990), 15 ea., $74,835.

Plastoid Corp., Hamburg, N. J., 6145-170-7837 cable, R.F. Type RG-9B/U in accord with Spec MIL-6145-170-7837 Contract AF 30(635)-21301, (IFB 30-635-61-96B), 175,-000 ft., $30,450.

Automatic Electric Sales Corp., Northlake, Ill., 400 line addition to automatic switching facility at Maxwell AFB in accord with ROZ-61-W-B-2. Contract AF30(635)-21543, (RFP 30-635-61-4804 Q), 1 ea., $32,633.

U. S. Wire & Cable Corp., Union, N. J., 6145-519-2820 cable, R.F. Type RG-177/U in accord with Spec Mil C-17. Contract AF 30(635)-21681, (IFB 30-635-61-179 B), 50,000 ft., $26,587.

Rockbestos Wire & Cable Co., New Haven, Conn., high temperature ignition wire in accord with MIL-C-20538. Contract AF 30(635)22065, 3 items, $29,458.

Canadian Commercial Corp., Ottawa, Canada, services for the removal of radome CW-208/CPS-6B at eight Pinetreee sites, part of Project CANDIN. Order on contract AF 30(635)-17273 job $32,000.

Sylvania Lighting Products, Buffalo, N. Y., aircraft instrument lighting, 6240-155-7784 lamp P/N 307, 6240-155-7924 lamp P/N 311, 6240-155-7848 lamp P/N 303. Order DO (30-635) 61-3070 on Contract GS-00S-32365—27 items—$234,487.

Westinghouse Electric Co., Syracuse, N. Y., 6240-186-6276 lamp P/N 1385, 6240-155-7784 lamp P/N 307, 6240-132-5328 lamp P/N 4570, end use: aircraft and airfields. Order DO(30-635) 61-3069 on Contract GS-00S-32367, 23 items, $315,091.

HEADQUARTERS, DAYTON AIR FORCE DEPOT, USAF, Gentile Air Force Station, Dayton, Ohio.

Sylvania Electronic Products, Inc., New York, N. Y., electron tube, Type 5814A in a/w MIL-E-1D dated Mar. 31, 1958 and individual Spec Sheet MIL-E-1/12C dated Mar. 27, 1959, S/N 5960-262-0210, estimated $350,000 ea. IFB 33-604-61-439, Contract Nr AF 33(604)31924, estimated $209,300.

Radio Corp. of America, Newark, N. J. electron tube, Type 803 in a/w Spec MIL-E-1/927A S/N 5960-116-9984, 1842 ea. IFB 33-604-61-431 Contract Nr AF 33(604)-36115, $63,364.

Constantine Engineering Laboratory, Inc., Mahwah, N. J., coil tube deflection, General Electric Co. P/N M7406185P2 S/N 5950-349-0459, 5 ea. PR: MD-1-5950-64172. Contract Nr AF 33(604)31516, $34,450.

Raytheon Co., Newton, Mass., electron tube, type 5656 in a/w Spec MIL-E-1/463 dated Jan. 7, 1954 S/N 5960-193-5131 12500 ea. IFB 33-604-61-420, Contract Nr AF 33(604)31498, $99,875.

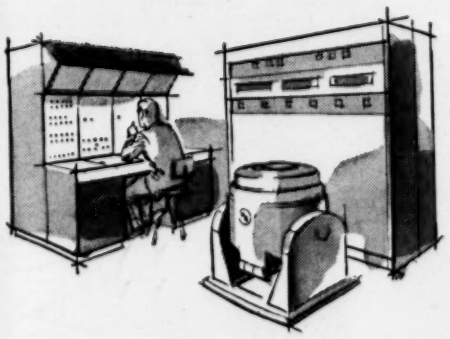
Jennings Radio Manufacturing Corp., San Jose, Calif., capacitor-variable-vacuum-dielectric, Jennings Radio LPS10-750 S/N 5910-681-2345, 150 ea. PR: MD-1-5910-32726, Contract Nr AF 33(604)31030, $33,376.

Kuthe Laboratories, Inc., Newark, N. J., electron tube Type 1257 in a/w Individual Spec Sheet MIL-E-1/968B dated June 23, 1959 S/N 5960-686-6755 450 ea. IFB 33-604-61-424. Contract Nr AF 33(604)31362, $195,750.

Caledonia Electronics & Transformer Corp., Caledonia, N. J., reactor transformer, General Electric Co. P/N 7730225P2 S/N 5950-578-1165 680 PR: MD-1-5950-64663, Contract Nr AF 33(604)31894, $42,989.

The important advances in environmental testing come from MB

Production random vibration now practical with MB completely automatic spectrum equalizer



Heart of the MB automatic equalization system is the multi-channel transistorized amplifier which provides amplitude control. The plug-in printed circuit assembly shown above contains four of these channels. Frequency control is provided by the 80-channel filter assembly in the compact metal box.

MB's completely automatic spectrum equalizer simplifies test procedure and makes production random vibration testing practical. It effects tremendous savings in test time and money for missile and aircraft manufacturers. The reason: set-up time has been completely eliminated. Using solid state magnetostrictive filters with correct phase properties plus servo systems on each of eighty channels in the 15 to 2000 cps spectrum, vibration shaker systems can be completely equalized within 5 seconds.

Savings in time and labor over previous equalization methods can easily mean thousands of dollars per missile tested. Still another advantage is the greatly increased accuracy of accumulated test data. The spectrum is continuously monitored in narrow bandpass channels and compensation automatically made *during* test run.

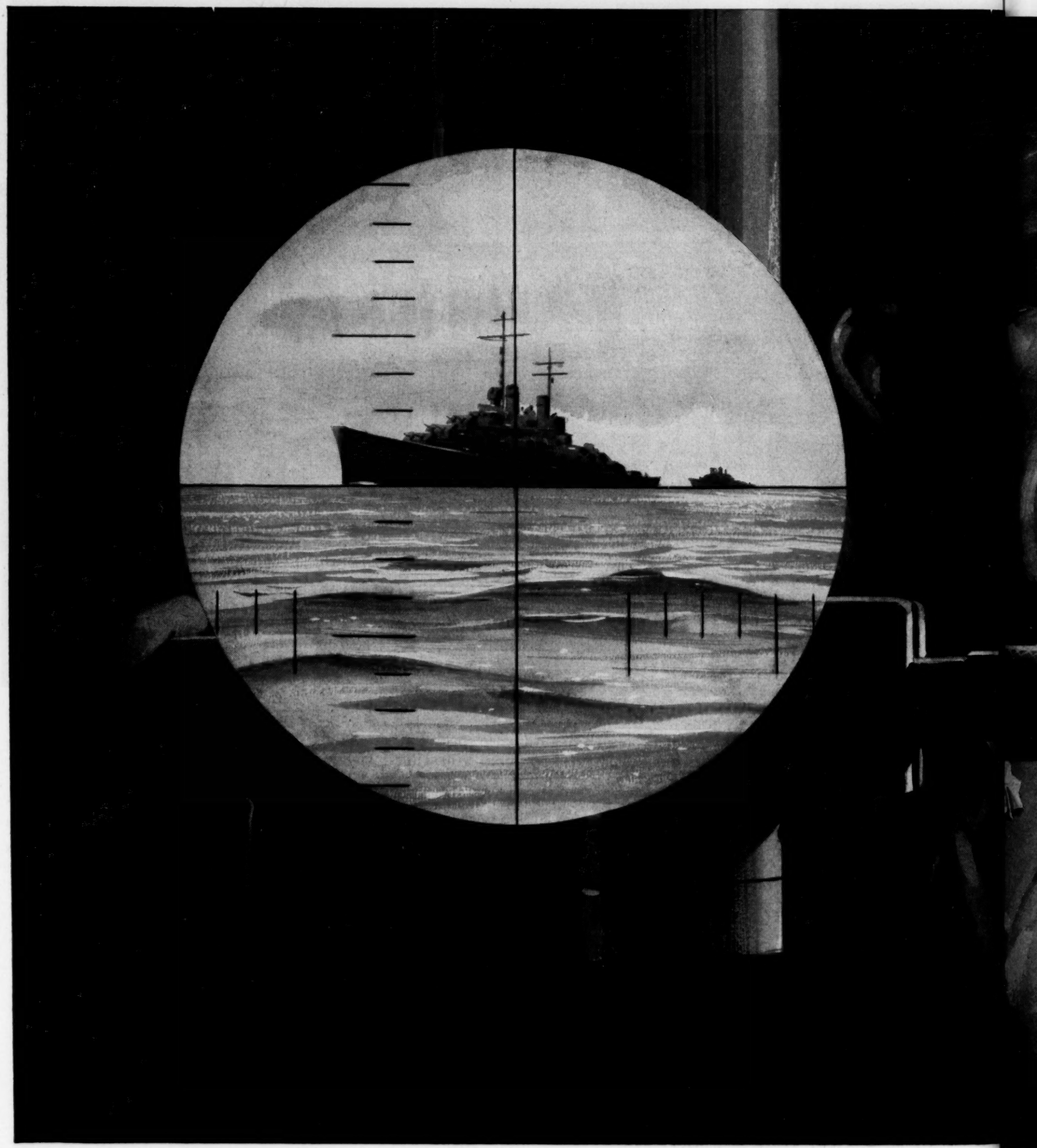
Automatic spectrum equalization is another of MB's important and continuing contributions in the field of environmental testing.

MB ELECTRONICS

A DIVISION OF TEXTRON ELECTRONICS, INC., 1078 State Street, New Haven 11, Conn.

SHIPS ON A SIMULATED SEASCAPE

CHANGE COURSE WITH



CHANGING WAR GAME TACTICS

Electronics duplicate naval maneuvers on an ocean miles wide and fathoms deep—captured within the confines of a single building.

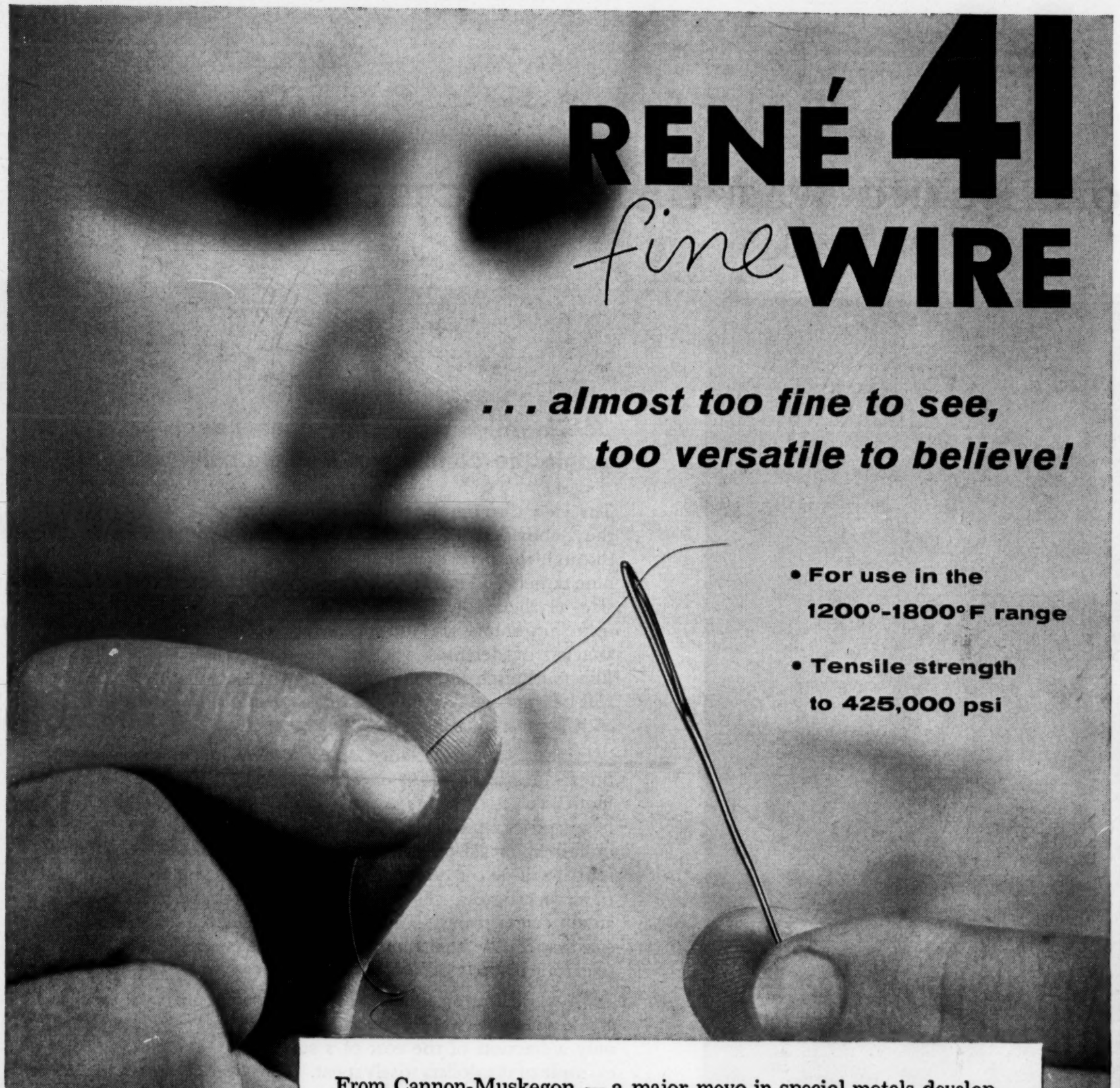
The view through the periscopes of Honeywell's attack centers for the Submarine Tactics Trainer will be as realistic as the view through the periscope of an actual atomic submarine! As many as nine targets will maneuver at proper speeds and change bearing and size as their courses dictate. Different types of weapons will make hits or misses as they would in actual individual or coordinated attacks, or defenses, without the expense of actual maneuvers. Effects of pitch and roll, night or day, fog or sunglare on the water will be imposed. All this will be programmed into the trainer once each second by a Honeywell 800 computer.

In short, the men being trained in these attack centers will have the feeling of engaging in active maneuvers. The flexibility of a Honeywell 800 computer will enable officers to experiment with new tactics and evaluate whether or not these would succeed or fail in actual practice. Two command centers and a critique room will allow participating officers to conduct war games, observe progress, change tactics and check performance of the attack center teams. The trainer can handle one to four problems simultaneously and thus submarine attack center crews can be trained separately or as a team.

Thus, without an atomic submarine leaving port, or the expense of actual maneuvers, a thorough training job can be done. Costing only a fraction of the cost of a submarine, the trainer is a good example of tax dollars wisely spent. Honeywell, as prime contractor, is developing and building the trainer at its Ordnance Division facility, Duarte, California, under the direction of the Naval Training Device Center, Port Washington, N. Y., for the Submarine School at New London, Conn. For more information on Honeywell management capabilities in the design and production of simulators and trainers, contact your local representative, or write: Honeywell Military Products Group, Minneapolis 8, Minn. *Sales and service offices in all principal cities of the world.*

Honeywell

H HONEYWELL *Military Products Group*



From Cannon-Muskegon — a major move in special metals development! Now the amazing properties of René 41 are yours to utilize in *fine-wire form*. This new vacuum-melted, high-temperature product is just .0015" in diameter . . . half the thickness of a human hair. One ton could circle the earth three times, four tons would reach the moon!

Yet thin as it is, René 41 fine wire has unusual strength. Under cold reduction, tensile strengths to 425,000 psi have been obtained. And even at 1800° F it maintains high oxidation resistance, exceptional tensile and yield strength.

René 41 fine wire is currently being used in the form of screens, filters, cables, strainers and casings for high-temperature applications.

René 41 and other vacuum-melted high-temperature alloys are also available in sheets up to 48" wide x 120" long, and in thicknesses down to .010. Bar stock is available up to 3" in diameter, and foil down to .001 in thickness.

Our metallurgists will furnish any help or data you may desire. Write Cannon-Muskegon.

ULTRA MET
VACUUM-MELTED ALLOYS
FOR INDUSTRY

CANNON-MUSKEGON CORPORATION

2800 Lincoln Avenue • Muskegon, Michigan, U.S.A.

3-5

METALLURGICAL SPECIALISTS

Officer Salaries Listed With SEC

Washington—Following is a list of aerospace industry directors and officers with 1960 salaries above $30,000 and their stockholdings, as reported to the Securities and Exchange Commission:

International Telephone and Telegraph Corp.—H. S. Geneen, president and director, $138,545 salary, 2,128 shares of common stock, bonus of 538 shares of common stock and $35,001; **C. D. Hilles, Jr.,** executive vice president and director, $82,000 salary, 14,062 shares of common stock, $2,500 convertible debentures; **L. T. Rader,** vice president, $86,520 salary and $26,697 nonrecurring payments, 100 shares of common stock, bonus of 215 shares of common stock and $14,006; **E. W. Stone,** vice president, $64,263 salary, 240 shares of common stock, bonus of 129 shares of common stock and $8,403; **G. R. Brown,** director, 23,200 shares of common stock partially owned, $44,400 convertible debentures partially owned; **A. M. Hill,** director, 13,500 shares of common stock, $25,000 convertible debentures; **A. P. Kirby,** director, 18,505 shares of common stock and 20,878 shares owned by corporations in which Kirby is a stockholder; **H. Knowlton,** director, 2,000 shares of common stock, including 1,000 shares held in a trust; **J. P. Lannan,** director, 7,909 shares of common stock, $15,818 debentures; **R. McKinney,** director, 31,400 shares of common stock including 3,000 shares held in trust, $313,000 convertible debentures including $127,000 held by company McKinney owns; **R. S. Perkins,** director, 1,000 shares of common stock; **W. L. Pierson,** 200 shares of common stock, $400 convertible debentures. Stocks are listed as of Mar. 1, 1960.

Kaman Aircraft Corp.—C. H. Kaman, president and director, $58,333 salary, 8,945 class A and 31,525 shares of class B common stock; **E. J. Odlum,** senior vice president and director, $41,958 salary, 2,454 shares of class A and 341 shares of class B common stock; **B. F. Clark,** director, 515 shares of class A common stock; **W. A. Coolidge,** director, 14,591 shares of class A and 11,768 shares of class B common stock; **K. W. Erickson,** director, no stock; **G. P. Gardner, Jr., director,** 824 shares of class A and 733 shares of class B common stock; **M. H. Glover,** director, 108 shares of class A and six shares of class B common stock; **E. S. Grant,** 627 shares of class A common stock; **E. B. Hotchkiss,** director, 430 shares of class A and 277 shares of class B common stock; **G. Morrissey,** director, 5,433 shares of class A and 609 shares of class B common stock; **J. S. Murtha,** director, 1,511 shares of class A and 30 shares of class B common stock. Stockholdings are listed as of March 1, 1961.

Lear, Inc.,—W. P. Lear, chairman of the board, $135,300 salary, 463,020-1/6 shares of common stock; **A. G. Handschumacher,** president and director, $66,250 salary, 434 shares of common stock; **R. M. Mock,** chairman of executive committee and director, $53,750 salary, 18,171 shares of common stock; **P. E. Golde,** senior vice president, secretary and director, $56,875 salary, 4,912 shares of common stock; **K. MacGrath,** director, 1,206-2/3 shares of common stock; **R. W. Millar,** director, 200 shares of common stock; **C. J. Reese,** director, 1,000 shares of common stock; **R. A. Stevenson,** director, 1,200 shares of common stock; **E. Adams, Jr.,** director (from June, 1960), 100 shares of common stock. Stocks are listed as of Apr. 15, 1961.

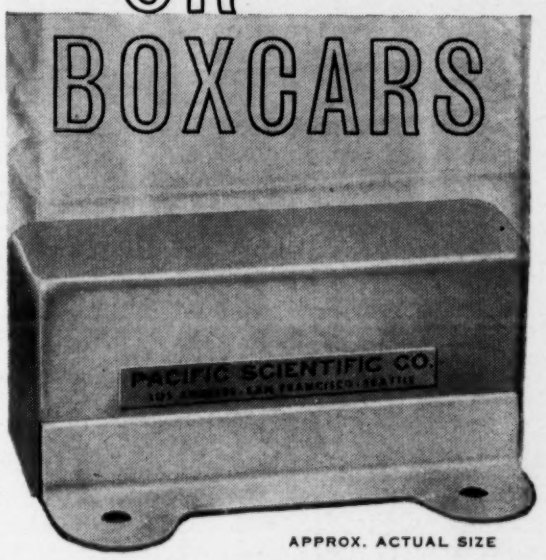
Ling-Temco Electronics, (Temco Aircraft Corp. and Ling-Altec Electronics, Inc., merged July 12, 1960)—**R. McCulloch,** chairman of the board and chief executive officer, $84,533 salary, 26,876 shares of common stock, 5,719 shares of series A preferred stock; **J. J. Ling,** president, director and chairman of the executive committee, $60,833 salary, 90,311 shares of common stock, $100,000 5.25% convertible debentures; **C. Skeen,** executive vice president, general manager and director, $71,200 salary, 3,240 shares of common stock, 60 shares of series A preferred stock; **L. D. Webster,** vice president, secretary, treasurer and director, $31,875 salary, 1,000 shares of common stock; **C. G. Pierce,** president of the Ling Electronics Division and advisory director, $35,000 salary; **J. O. Weldon,** president of Continental Electronics Mfg. Co. (a subsidiary) and director, $50,000 salary, 10,000 shares of common stock; **A. A. Ward,** president of Altec Companies, Inc., (a subsidiary) and director, $31,317 salary, 1,927 shares of common stock; **D. H. Byrd,** director, 73,953 shares of common stock, 18,245 shares of series A preferred stock, $46,000 5.25% convertible debentures; **J. M. Crumby,** director, 148 shares of common stock, 37 shares of series A preferred stock; **V. A. Davidson, M.D.,** director, 4,156 shares of common stock; **O. R. Moore,** director, 26,911 shares of common stock, 6,804 shares of series A preferred stock; **H. F. Volk,** director, 21,600 shares of common stock, 5,400 shares of series A preferred stock. Stockholdings are listed as of January 31, 1961.

Minneapolis-Honeywell Regulator Co.—H. W. Sweatt, chairman of the board and director, $125,000 salary, 82,265 shares of common stock; **P. B. Wishart,** president and director, $135,000 salary, 10,010 shares of common stock; **T. McDonald,** executive vice president and director, $85,000 salary, 7,775 shares of capital stock; **A. M. Wilson,** executive vice president and director, $85,000 salary, 6,700 shares of common stock; **J. H. Binger,** vice president and director, $54,583 salary, 9,628 shares of common stock; **S. F. Keating,** vice president and director (since 1960), $54,583 salary, 1,970 shares of common stock; **C. B. Sweatt,** director, 64,594 shares of common stock; **W. L. Huff,** director, 10,200 shares of common stock; **C. J. C. Quinn,** director, 400 shares of common stock; **R. P. Brown,** 52,737 shares of common stock; **C. C. Buckland,** vice president, secretary and director, 2,137 shares of common stock; **J. J. Wilson,** director, 32,770 shares of common stock; **D. C. Swatland,** director, 100 shares of common stock; **F. Maytag II,** director, 100 shares of common stock; **P. S. Gerot,** director, 200 shares of common stock. Stockholdings are listed as of February 1, 1961.

Raytheon Co.—C. F. Adams, chairman of the board and director, $134,533, salary, 33,742 shares of common stock; **R. E. Krafve,** president and director (since Apr. 14, 1960), $111,200 salary, 4,050 shares of common stock; **P. L. Spencer,** director and senior vice president $77,200 salary, 2,188 shares of common stock; **R. C. Damon,** director, 105 shares of common stock; **D. S. Edmonds,** director, 38,400 shares of common stock, 14,500 shares of 5.5% series preferred stock, 23,537 shares of common and 9,080 shares of 5.5% series preferred stock held in a trust of which Edmonds is co-trustee; **C. J. Gilbert,** director, 525 shares of common stock; **G. L. Langreth,** director, 366 shares of common stock; **S. P. Lovell,** director, 657 shares of common stock; **R. W. Stoddard,** director, 231 shares of common stock. Stocks are listed as of Feb. 23, 1961.

Republic Aviation Corp.—M. I. Peale, president and director, $131,166 salary, 4,939 shares of common stock; **H. S. Jones,** executive vice president and director (since 1960), $116,000 salary, 200 shares of common stock; **T. Davis,** vice president, $70,000 salary; **R. L. Clarkson,** director, 146 shares of common stock; **F. G. Coburn,** director (retired), 300 shares of common stock; **A. Kartveli,** vice president-research and development and director, 2,928 shares of common stock; **W. H. Moore,** director, 605 shares of common stock; **L. Platt,** director, 292 shares of common stock; **W. V. Platt,** director, 100 shares of common stock; **L. Platt,** director, 292 shares of common stock; **W. V. Platt,** director, 100 shares of common stock; **H. N. Taylor,** director, 200 shares of common stock; **R. C. Taylor,** director, 511 shares of common stock; **J. J. Tuohy,** director (since Oct. 27, 1960), 100 shares of common stock. Stocks are listed as of Feb. 1, 1961.

FOR "BIRDS" OR BOXCARS



APPROX. ACTUAL SIZE

New PACIFIC "G" SENSING INERTIA SWITCH

...provides high performance ...reliable acceleration switching!

Pacific's new inertia switch is readily adaptable to meet a variety of "G" sensing uses from missiles to freight cars. It permits a wide variation in performance and range with only a minimum of engineering and development to meet specific requirements. A unique switching action provides positive "make or break" action of the electrical contacts at the "G" setting regardless of environmental conditions.

For information on Pacific inertia switch designed to your own requirements...or on a standard unit, WRITE TODAY. The engineering skill and creative ability of Pacific Scientific are at your service.

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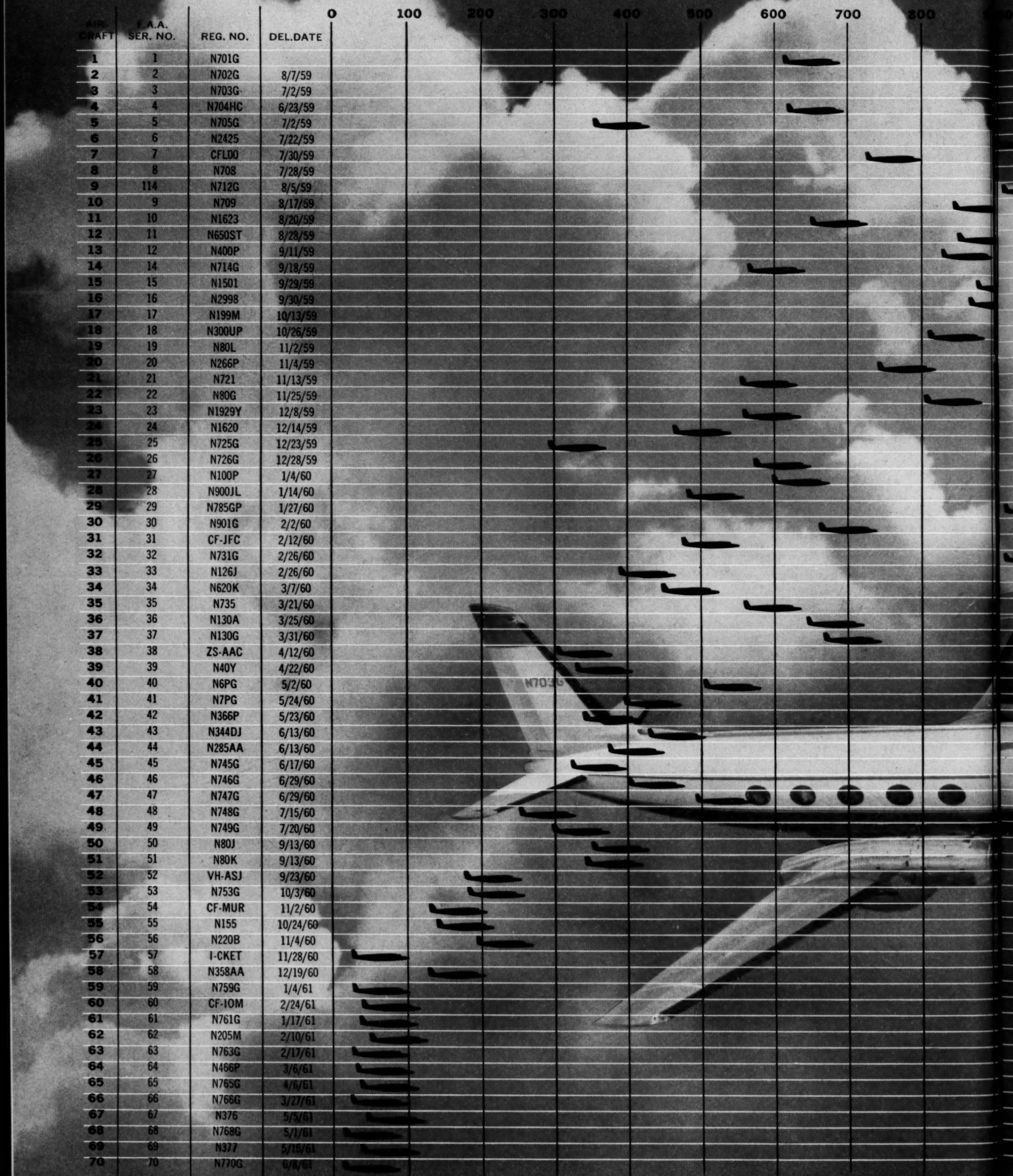
FLYING HOURS SINCE F.A.A. CERTIFICATION.

AIR-CRAFT	F.A.A. SER. NO.	REG. NO.	DEL.DATE
1	1	N701G	
2	2	N702G	8/7/59
3	3	N703G	7/2/59
4	4	N704HC	6/23/59
5	5	N705G	7/2/59
6	6	N2425	7/22/59
7	7	CFLDO	7/30/59
8	8	N708	7/28/59
9	114	N712G	8/5/59
10	9	N709	8/17/59
11	10	N1623	8/20/59
12	11	N650ST	8/28/59
13	12	N400P	9/11/59
14	14	N714G	9/18/59
15	15	N1501	9/29/59
16	16	N2998	9/30/59
17	17	N199M	10/13/59
18	18	N300UP	10/26/59
19	19	N80L	11/2/59
20	20	N266P	11/4/59
21	21	N721	11/13/59
22	22	N80G	11/25/59
23	23	N1929Y	12/8/59
24	24	N1620	12/14/59
25	25	N725G	12/23/59
26	26	N726G	12/28/59
27	27	N100P	1/4/60
28	28	N900JL	1/14/60
29	29	N785GP	1/27/60
30	30	N901G	2/2/60
31	31	CF-JFC	2/12/60
32	32	N731G	2/26/60
33	33	N126J	2/26/60
34	34	N620K	3/7/60
35	35	N735	3/21/60
36	36	N130A	3/25/60
37	37	N130G	3/31/60
38	38	ZS-AAC	4/12/60
39	39	N40Y	4/22/60
40	40	N6PG	5/2/60
41	41	N7PG	5/24/60
42	42	N366P	5/23/60
43	43	N344DJ	6/13/60
44	44	N285AA	6/13/60
45	45	N745G	6/17/60
46	46	N746G	6/29/60
47	47	N747G	6/29/60
48	48	N748G	7/15/60
49	49	N749G	7/20/60
50	50	N80J	9/13/60
51	51	N80K	9/13/60
52	52	VH-ASJ	9/23/60
53	53	N753G	10/3/60
54	54	CF-MUR	11/2/60
55	55	N155	10/24/60
56	56	N220B	11/4/60
57	57	I-CKET	11/28/60
58	58	N358AA	12/19/60
59	59	N759G	1/4/61
60	60	CF-IOM	2/24/61
61	61	N761G	1/17/61
62	62	N205M	2/10/61
63	63	N763G	2/17/61
64	64	N466P	3/6/61
65	65	N765G	4/6/61
66	66	N766G	3/27/61
67	67	N376	5/5/61
68	68	N768G	5/1/61
69	69	N377	5/15/61
70	70	N770G	6/8/61



Shown above: actual recorded flight time on Gulfstream aircraft—May 1959 to July 1961.

Grumman Gulfstreams set outstanding utilization records! Fly 68 million passenger miles since May 1959

One Gulfstream, owned by George W. Crothers Limited, traveled 171,000 passenger miles in just one week!

68 million passenger miles! 35,000 flying hours! *All* in just 26 months, from F.A.A. certification in May 1959 to July 1961....

This is aircraft utilization at its best . . . aircraft utilization that only a Gulfstream can deliver. For it is the only aircraft in its class designed exclusively as a business airplane!

The result: the Gulfstream offers unique flight and ground flexibility. It's the most do-everything business airplane there is—one of the most useful *and* usable business airplanes in the world!

For a good example of this, just consider the experience of George W. Crothers Limited of Toronto, Ont. This company's Gulfstream traveled 171,000 passenger miles in just seven days!

Starting on a Sunday and for seven consecutive days on a daily basis—the Crothers' Gulfstream ran scheduled trips between Toronto and Tampa, Florida. The purpose of these trips was to airlift top Canadian customers to Tampa for demonstrations of a new line of tractors handled by Crothers Limited.

The seven-day Crothers flight log tells the Gulfstream utilization story with dramatic detail.

	DEPARTED	ARRIVED	DEPARTED	ARRIVED
Sunday	Toronto 07:57 Ft. Lauderdale 14:20	Tampa 12:04 Toronto 18:25	Tampa 12:42	Ft. Lauderdale 13:35
Monday	Toronto 08:10	Tampa 11:28	Tampa 13:08	Toronto 17:06
Tuesday	Toronto 08:24	Tampa 11:45	Tampa 12:47	Toronto 16:44
Wednesday	Toronto 07:52	Tampa 11:29	Tampa 12:50	Toronto 16:34
Thursday	Toronto 07:57	Tampa 11:42	Tampa 12:53	Toronto 16:27
Friday	Toronto 07:59	Tampa 12:25	Tampa 13:26	Toronto 16:52
Saturday	Toronto 07:34	Tampa 11:05	Tampa 12:37	Toronto 16:27

Flight performance like this—performance that makes the Gulfstream ideal for 71-mile or 7100-mile trips—is one reason why 70 Gulfstreams are now in operation. Other reasons are Gulfstream's proven safety, reliability, comfort and beauty. It's a sound investment.

Corporate executives and pilots may arrange for demonstration flights through the following distributors. In the United States: Atlantic Aviation, Wilmington, Del.; Pacific Airmotive, Santa Monica, Cal.; Southwest Airmotive, Dallas, Tex. In Canada: Timmins Aviation, Montreal. In Europe: Atlantic Aviation Export Corporation, London, England.

GRUMMAN

AIRCRAFT ENGINEERING CORPORATION

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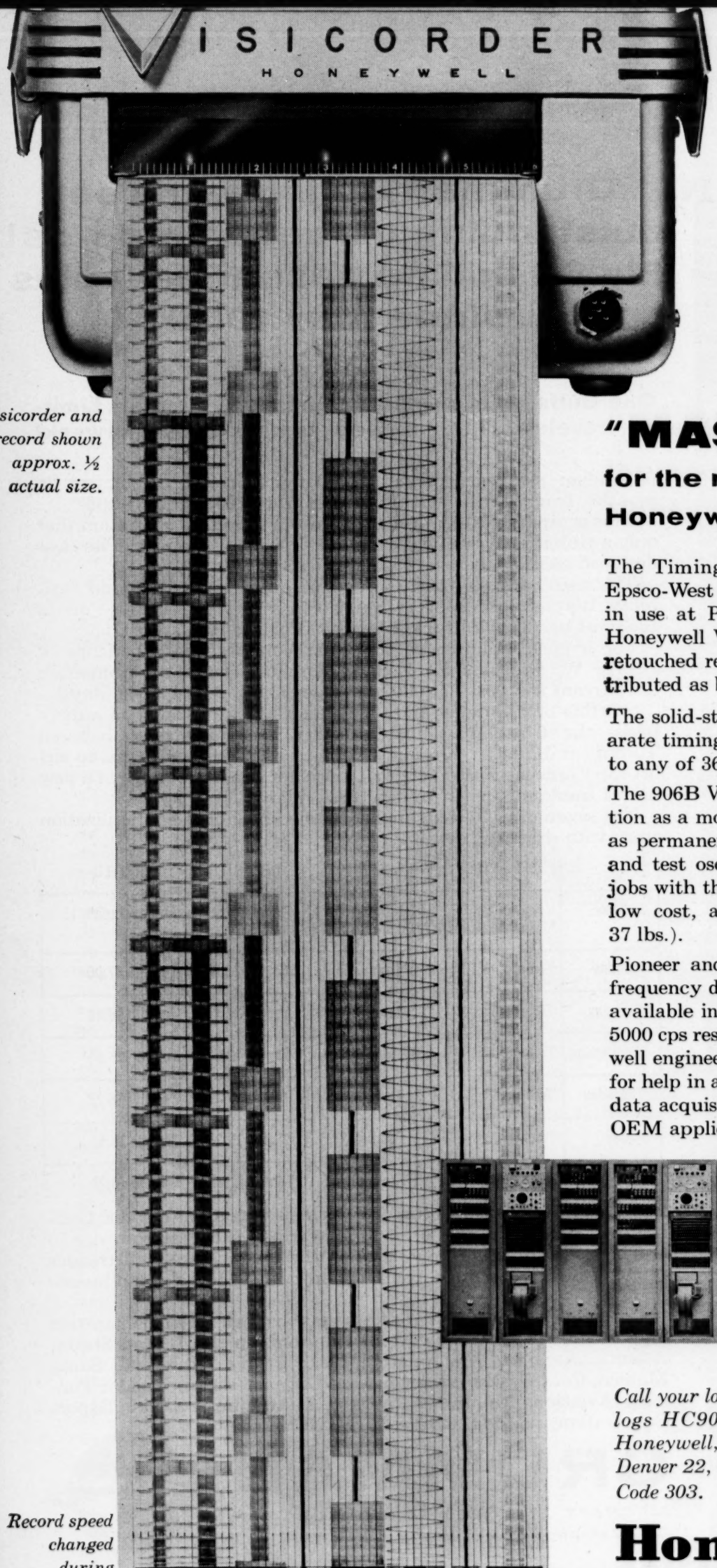


Visicorder and record shown approx. ½ actual size.

Record speed changed during recording.

"MASTER CLOCK"

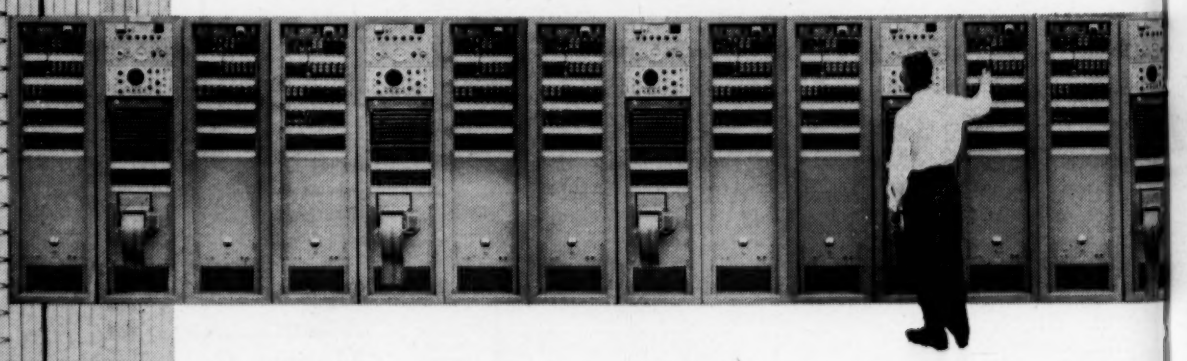
for the missile range uses 15 Honeywell Visicorder oscillographs

The Timing Operations Center designed and built by Epsco-West for the Navy's Pacific Missile Range is now in use at Point Mugu, California. It makes use of 15 Honeywell Visicorders to read out (as shown on the unretouched record at left) the modulated timing codes distributed as balanced outputs to the Center's "customers."

The solid-state Epsco-West TOC generates up to 11 separate timing signals, one or all of which may be delivered to any of 36 users.

The 906B Visicorder also performs a supplementary function as a monitor on the timing and test-patch panel, and as permanent "record-keeper" for the built-in indicators and test oscilloscopes. Visicorders were selected for their jobs with the TOC because of their versatility, reliability, low cost, and compact size ((10″ x 10″ x 15½″; weight, 37 lbs.).

Pioneer and acknowledged standard in the field of high frequency direct-recording oscillography, the Visicorder is available in several models, from 6 to 36 channels, DC to 5000 cps response, up to 50,000″/sec writing speed. Honeywell engineering is at your service through 120 field offices for help in applying one Visicorder or a full system to your data acquisition program; or a quantity of Visicorders for OEM application in your products.



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Honeywell

First in Control

SINCE 1885

Space Role Seen for Small Rocket Family

By Russell Hawkes

Canoga Park, Calif.—Family of smaller rockets designed to operate in deep space is under development by Rocketdyne Division of North American Aviation as a complement to its big booster program.

The company-funded program is based on a conclusion that there is a time gap between chemical rockets now being designed for spacecraft and projected nuclear and nuclear-electric engines. Rocketdyne believes space program officials will soon reach the same conclusion and hopes the company-funded project will provide a competitive edge.

The Small Space Engine project is aimed at the development of three or more rockets in three broad size ranges for three general categories of application. The three lines of attack are designated SE-1, SE-2, and SE-3. Size ranges and proposed applications are:

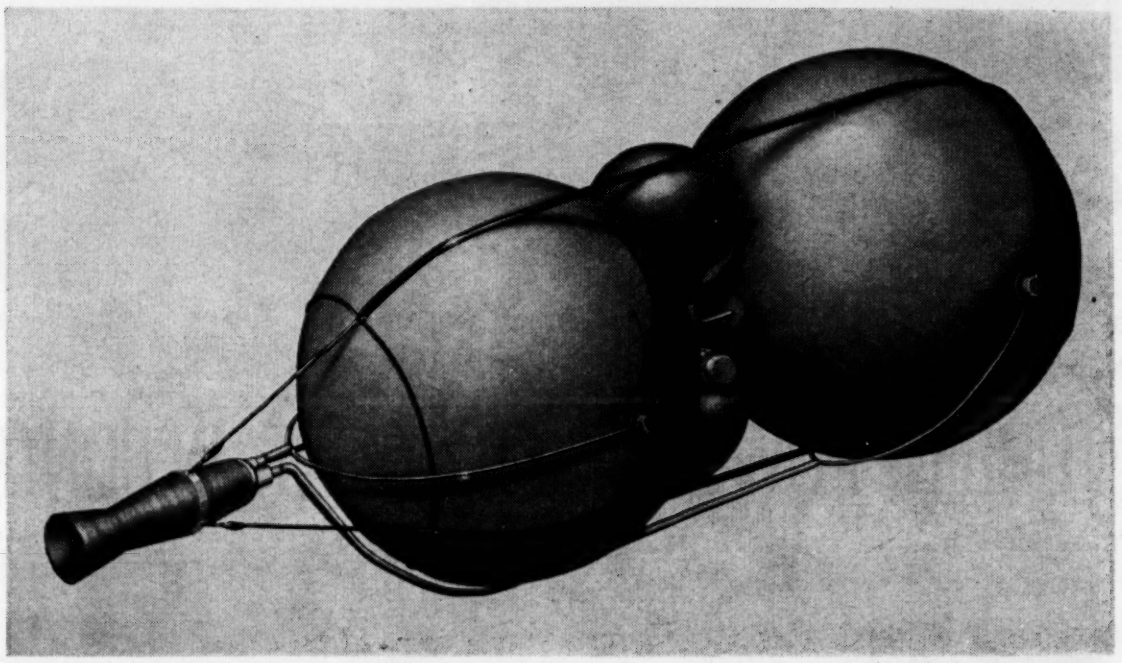
- **SE-1**—Attitude control engines producing from 0.1 lb. to 500 lb. thrust.
- **SE-2**—Retro and orbit change engines developing 10 lb. to 10,000 lb. of thrust.
- **SE-3**—Spacecraft propulsion systems in the 5,000-30,000 lb. thrust class.

First SE-3 engine was called Nomad. It was evaluated by USAF and dropped. Rocketdyne engineers are now working on another SE-3 engine of more advanced concept. Unlike Nomad, the new SE-3 chamber is uncooled. Test firings have been conducted at the company's Santa Susana Space Engine Test Facility.

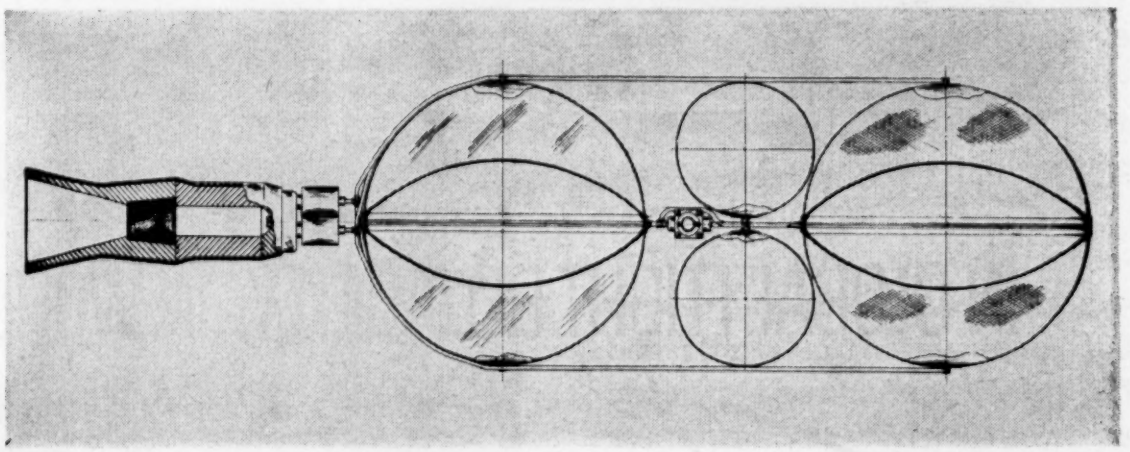
Other Innovations

In the smaller SE-1 and SE-2 classes, Rocketdyne is working on three other innovations: a throttleable liquid propellant rocket with propellant flow controlled by varying the cross-sectional area of the injector openings; a radiation cooled, thin wall chamber, and an ablation or transpiration cooled chamber of glass fiber and resin laminations. Rocketdyne projects aimed at a general advance of the technology include development work on fast-acting propellant valves and techniques of positive expulsion of propellant from tanks under low or random accelerations.

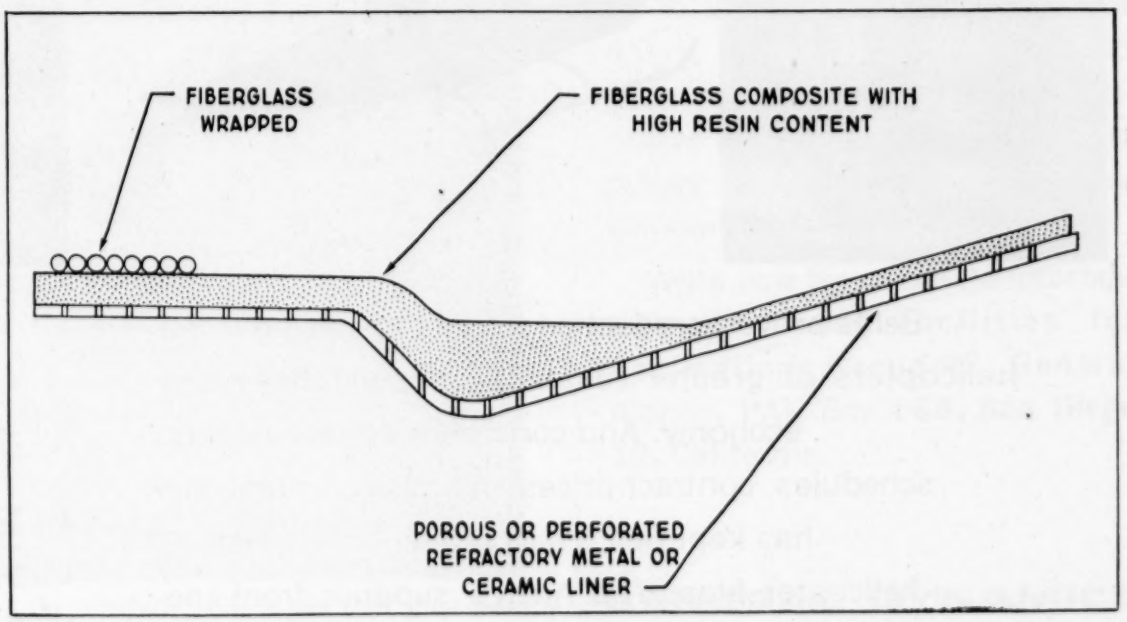
The variable area injector is somewhat similar to one developed by the Naval Ordnance Test Station, China Lake, Calif. Propellant flow is throttled by advancing or retracting a taper-



ARTIST'S CONCEPTION of experimental SE-1 spacecraft attitude control engine, which has made test runs of up to 22 min., shows light spherical tanks in tension structure. Small spheres pressurize propellant expulsion bladders.



CUTAWAY of the experimental SE-1 system shows positive expulsion bladders in the propellant tanks. The small space engine also was used to test fast acting solenoid valves and has been stopped and restarted at pulse rates up to 26 cps.



ADVANCED SE-1 small engine will be lined with porous or perforated ceramic or refractory metal. Transpirational rather than ablative cooling should cut weight 30% by allowing a bigger ratio of cooling resin to structural glass in chamber walls.

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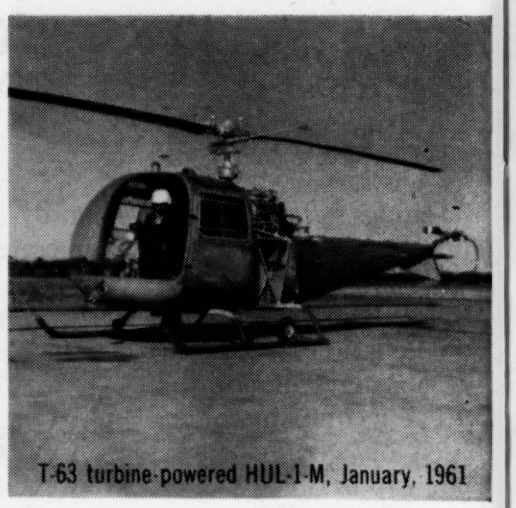
Turbine-powered Sioux, 1954

T-53 turbine-powered XH-40, 1956



T-63 turbine-powered HUL-1-M, January, 1961

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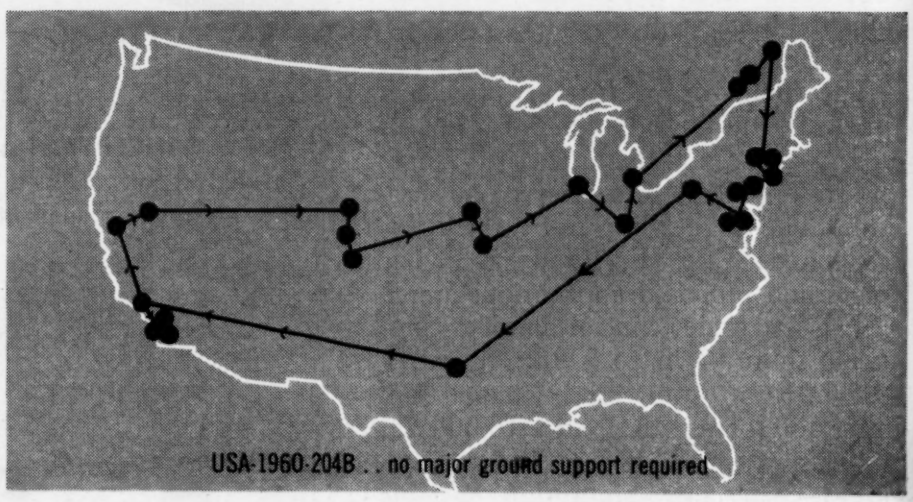

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edged, ring-shaped valve in an annular propellant inlet port. Fuel is injected from the inner side of the ring in an expanding cone-shaped pattern and oxidizer is injected from the outer side of the ring in a cone-shaped pattern.

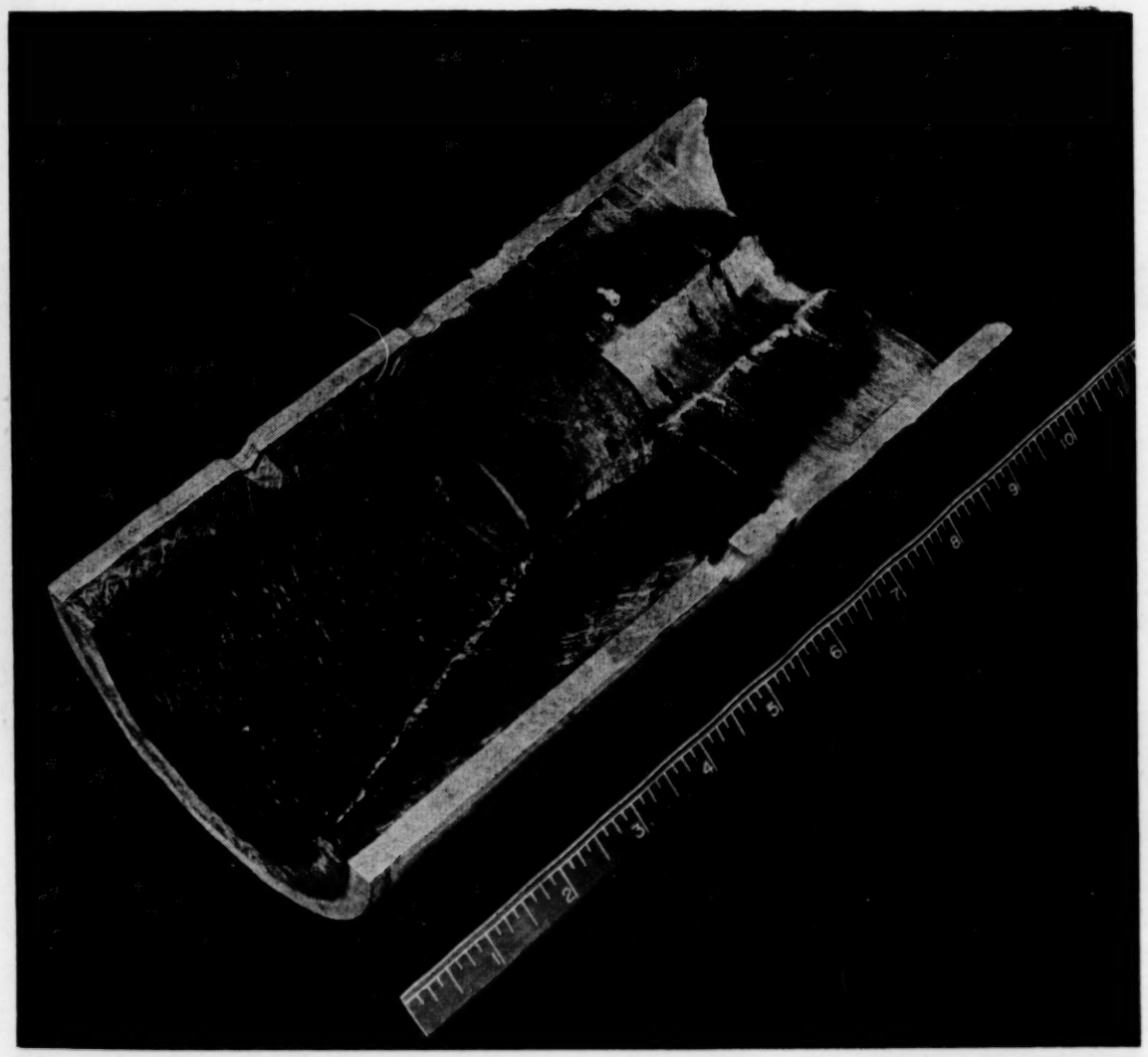
Unlike the China Lake development, the Rocketdyne throttled chamber has serrated surfaces so that propellants flow into the chamber in ribbons whose widths and thicknesses are both controlled by the position of the ring-shaped valve. The China Lake engine injected fuel from one side of the ring and oxidizer from the other in intersecting conical sheets of liquid and only thicknesses could be varied. Rocketdyne engineers claim that by breaking the conical sheets of flowing propellant into ribbons of variable widths, they can accept less stringent positioning accuracy of the ring-shaped valve.

Throttling Results

Using this approach, Rocketdyne has achieved a 15 to 1 throttling ratio with thrusts as low as 75 lb. and as high as 1,200 lb. from the same chamber. Rocketdyne engineers who designed the variable area injector admit that breaking propellant flow into ribbon shaped streams causes some departure from the best fuel-oxidizer mixture because the streams cannot be made to impinge on each other with perfect accuracy. However, they believe that the efficient use of propellant made possible by throttling makes the loss negligible by comparison.

Regenerative cooling is impractical with the throttled engine. A regenerative cooling system designed to be adequate at maximum thrust would not function satisfactorily at low thrust levels because the pressure drop from the inlet to the outlet of the cooling jacket would be too small and flow rate would drop below that needed to carry off the heat flux into the chamber walls. Regenerative cooling is also being abandoned in SE-1 pulsed engines in which pulse rate and width rather than thrust are varied to control the total impulse applied to the vehicle. Regenerative cooling causes a lag in start-stop sequences because the cooling jacket must be filled before ignition and the jacket cannot be left full between burning periods because the propellant tends to boil off. Rocketdyne engineers say these problems can be solved but the solutions would be costly.

Instead, their interest is shifting to chambers cooled by radiation and by ablation or transpiration. The company has successfully tested an impressive SE-2 size engine that radiates all the heat passed into the chamber walls. The chamber is made of welded segments of molybdenum alloyed with ½% ti-



SECTIONED SE-1 test engine after firing shows the relatively undamaged fiber glass laminations of the chamber and the expansion cone. Dimensions are only slightly changed though resin laminations have cooked out from between the glass layers to provide a cooling boundary layer. Engine ran for 22 min. during the test.

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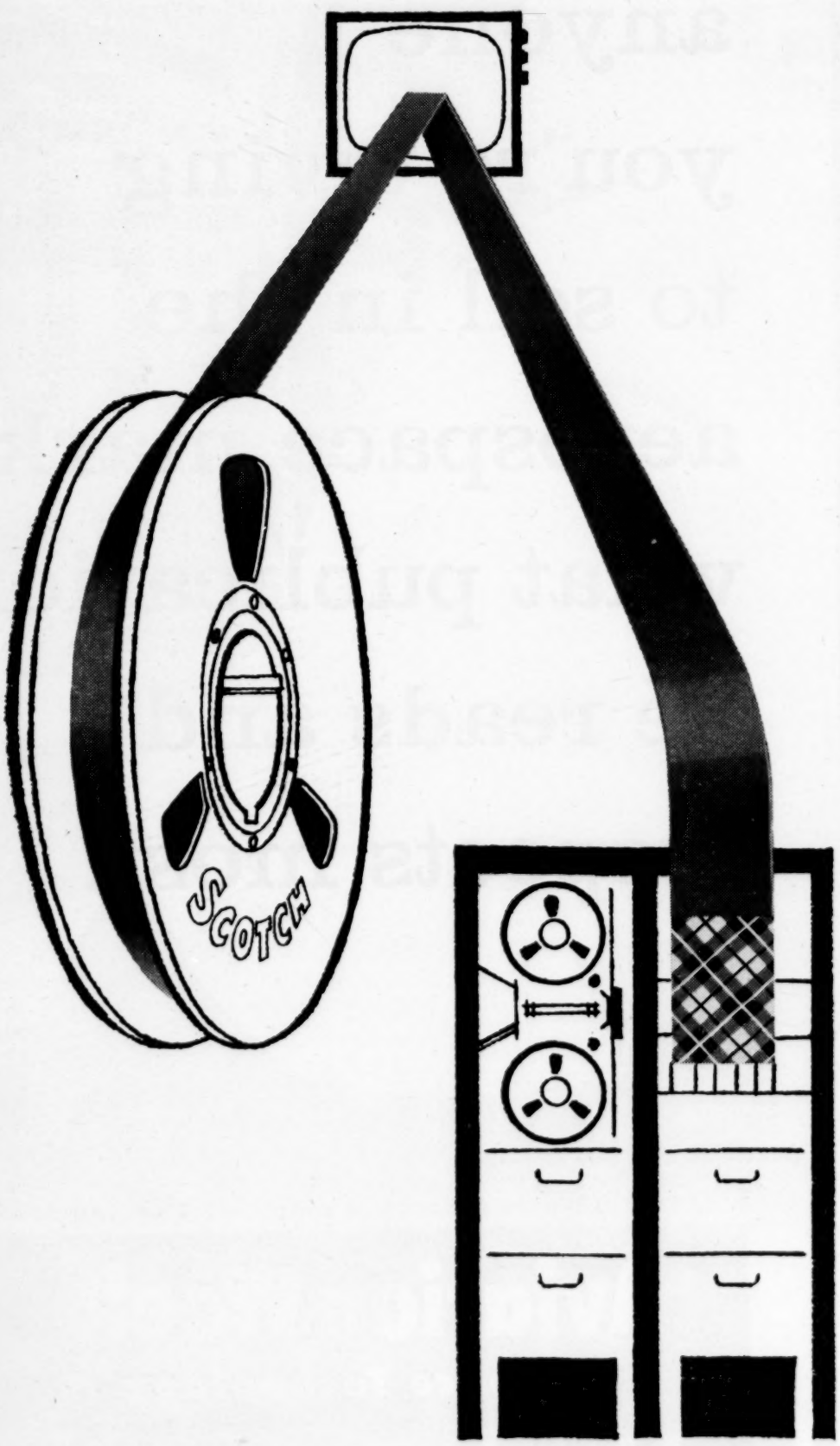
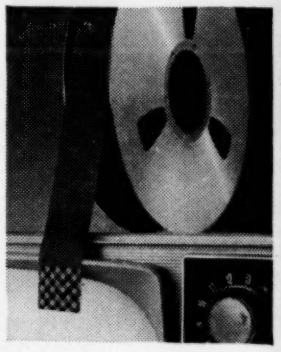


THE TIE that binds television's top performer to instrumentation tape is strong—and it goes beyond the fact that the same expert team produces the best of both. "SCOTCH" BRAND Heavy Duty Tapes share a common heritage—and uncommon endurance—with "SCOTCH" BRAND Video Tape, the tape that puts a network TV show on the same "clock time" from Maine to California.

Similarities worth noting between the two: a similar high-temperature binder system, famous "SCOTCH" BRAND high potency oxides, a similar ability to resist tremendous speeds, pressures and temperatures while providing high resolution.

Let's look at the record of "SCOTCH" BRAND Video Tape and see what message it has for the user of instrumentation tape. On a standard reel of video tape like that shown here, some 1½ million pulses per second must be packed to the square inch—on a total surface area equal to the size of a tennis court. The tape must provide this kind of resolution while defeating the deteriorating effects of high speeds, pressure as high as 10,000 psi and temperatures up to 250°F.



The fact is that video tape must be essentially perfect. And it's a matter of record that thus far only the 3M experts have mastered the art of making commercial quantities of video tape that consistently meet the demands of the application.

Significantly, the high-temperature binder system developed for "SCOTCH" Video Tape is first cousin, only slightly removed, to that used in the Heavy Duty Tapes. It's this special feature that has given Heavy Duty Tapes their exceptional wear life.

The moral emerges: for tape that provides the best resolution of high and low frequencies under the severest conditions, turn to "SCOTCH" BRAND Heavy Duty Tapes 498 and 499.

They offer the high temperature binder system, plus the same high quality and uniformity that distinguish all "SCOTCH" BRAND Tapes. As the most experienced tape-makers in the field, 3M research and manufacturing experts offer tape of highest uniformity—from reel to reel and within the reel. Check into the other "SCOTCH" BRAND constructions: High Resolution Tapes 457, 458 and 459; High Output Tape 428; Sandwich Tapes 488 and 489; and Standard Tapes 403 and 408.

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tanium. Rocketdyne officials believe it is the first time molybdenum has been welded successfully by a method suitable for production scale use. The walls are thin with no inserts or heat sinks.

Thickness of the walls is a nearly constant .035 in. throughout. The walls reach equilibrium and radiate heat at the same rate it is added from the combustion chamber after less than two seconds of operation. There is no significant limit to the length of time the chamber can operate without heat damage once equilibrium is reached. Equilibrium temperature in tests has ranged between 2,300F and 2,500F burning hydrazine and nitrogen tetroxide. With hotter burning high performance propellants, molybdenum can accept an equilibrium temperature up to 3,000F.

Test Engine

The test engine is designed to develop 500 lb. thrust at altitude and tests have been conducted at 35 psi. chamber pressures. The weight of the chamber is set at 8 lb. with a 40 to 1 expansion cone.

Rocketdyne engineers said that a conventional chamber developing the same thrust at the same chamber pressure would weigh about eight times as much.

Propellant lines between the tanks and the injector are simple thin tubes to prevent heat from being conducted forward into the tanks through manifold walls and structure. The rearward flow of propellant in the thin tubes tends to carry conducted heat back into the chamber.

Prevention of damage to the rest of the vehicle by radiated heat will be an important problem in the design of installations for the radiation cooled engine.

During one of the static tests, the wooden tripod of a data camera burst into flames and was consumed by radiated heat at a distance of about 10 ft. to one side of the motor. Solution in the design of a spacecraft would be a mirror-like reflector to turn radiant energy away from other parts of the vehicle.

Rocketdyne engineers say that radiation cooling would be even more effective in space than in the laboratory. It is true that there may be as much as 3% heat rejection by conduction and convection to the atmosphere in ground tests but the effectiveness of radiation processes is hindered by the higher energy 'back-pressure' of the atmosphere.

The small glass and plastic engine which looks most promising for SE-1 applications uses a form of ablative cooling that is very similar to tranpiration cooling in the combustion chamber.

The nozzle throat is a graphite insert. The combustion chamber and expansion cone walls are transverse laminations of glass fiber and resin. During operation, the resins cook out to form a relatively cool boundary layer along the chamber walls. Unlike most ablation cooling, this does not change the dimensions of the chamber very much because the glass fiber layers are not consumed. Rocketdyne engineers are about to test a similar chamber with the addition of a perforated lining of ceramic or refractory metal to make it true transpirational cooling and enable the proportion of cooling resin to be increased.

The SE-1 engines have been tested with pulsed combustion at pulse rates up to 26 cps. The ablative cooling keeps the internal surface temperature under 2,800F and the external surface reaches only 380F after 22 min. of operation. The engine develops 50 lb. of thrust burning Hydyne and nitrogen tetroxide.

Test versions have been made with injectors of aluminum and of phenolic-refrasil.

Important Techniques

Important techniques and devices investigated during tests of this chamber include positive expulsion of propellants, fast acting propellant valves and a minimum volume injector.

Positive expulsion technique is to inflate a bladder until it fills the tank and drives out all propellant. Purpose is to sustain a flow of propellant without much of an acceleration present to bring the propellant to the tank exit. Another equally important purpose is to keep propellant from being concentrated in one part of the tank and thereby shifting the center of gravity of the vehicle. Use of positive expulsion to hold center of gravity in one place would ease design requirements for attitude control and guidance systems. Rocketdyne is experimenting with elastomeric and corrugated aluminum diaphragms to move the propellant.

U.S., Argentina Plan Joint Rocket Program

Washington—Agreement providing for a cooperative sounding rocket program has been signed by the U. S. and Argentina.

The two countries will exchange scientists, and the U. S. will provide several types of sounding rockets, ranging from the Arcas to the Javelin, for Argentinian experiments in meteorology, ionospheric physics and cosmic ray detection studies.

Argentina currently is surveying areas on its southern coast as possible rocket launching sites.

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Clauser Technology Corp., Torrance, Calif., will study feasibility of a magnetic induction plasma engine for space vehicles under a contract exceeding $100,000 from NASA. Development will involve single-shot and repetitive firing engines utilizing interaction force between a traveling magnetic field and a gaseous plasma.

General Dynamics Astronautics will build three Atlas missile procedure trainers for the Air Force under a $2.5-million contract. First of the trainers will be delivered to the 576th Strategic Missile Squadron at Vandenberg AFB later this year. The trainers require no fuel, gases or other expendable materials, will be used in teaching such operational procedures as checkout, communications, readiness monitoring, countdown and simulated launching. Trainers cover an area 50 x 90 ft.

Cubic Corp., San Diego, has received a $300,000 contract from NASA for updating the space probe tracking network at NASA's Wallops Island, Va., station.

Pan American World Airways was awarded an $87.7-million contract to operate the Atlantic Missile Range for Fiscal 1962. Fixed fee to PAA is $1.75 million, the same amount as in Fiscal 1961.

National Research Corp. has a $61,900 National Aeronautics and Space Administration contract to study the effects of the space environment on six types of bacteria.

Northrop Corp. has a $62.3-million Air Force contract for production of T-38 trainers, spares and ground equipment.

Lycoming TVO-435 turbo-supercharged engine, currently in production for use on the Bell 47G-3, has been certificated by the FAA.

Weser Flugzeugbau GmbH. will establish a service facility for maintenance and repair of the Lockheed JetStar at Bremen, West Germany. Weser will service the first JetStars operating in Europe.

Lockheed Aircraft Corp. has signed agreements with Italy on an F-104 production program which includes a final assembly line at Fiat's Turin factory and participation by Aeronautica Macchi and Aerfer. Alfa Romeo is scheduled to take part in J79 engine production under General Electric license, probably with Fiat in Milan. The program is to be coordinated with F-104 production in West Germany, Belgium and The Netherlands.

Atomic Energy Commission plans to issue a permit to Northrop Corp. authorizing construction of a 100-kw. Triga Mark 7 pulsing reactor at the company's Pulse Radiation Facility, Hawthorne, Calif., for use in studying radiation effects on space vehicle systems and components.

Chicago Aerial Industries will install reconnaissance systems in Army's Grumman Mohawk aircraft under a $540,000 contract awarded recently. Another contract, valued at $1.6 million, provides for continued production of Iris reconnaissance cameras for use in supersonic Navy jet aircraft. The two contracts, totaling more than $2.1 million, raised CAI's order backlog to more than $7 million. The Iris camera features a proprietary focal plane shutter that operates at 1/3,000 sec., or about seven times faster than previous camera standards.

Hughes Aircraft Co. will develop plastic materials to line missile exhaust nozzles under a $124,000 contract from Air Force's Aeronautical Systems Division. The contract also calls for development of self-cooling techniques for the plastics, which are intended to resist highly erosive and chemically reactive exhaust of advanced propellants.

Minnesota Mining and Mfg. Co.'s Zenith Plastics Division will develop prototype reinforced plastic containers for transporting Air Force Minuteman ICBMs by air and rail under a contract from The Boeing Co. Value of the contract is approximately $350,000.

Marquardt Corp. will develop a bombardier/navigator radar training system under contract from Air Force. Designated MK-509/APQ-T10, the trainers will be used by Strategic Air Command and Air Training Command for training of B-52 bombardiers and navigators on simulated tactical missions. With a trainer map measuring approximately 72 by 48 in., a land and water area 3,000 by 2,000 mi. can be represented on the radar scope.

Space Technology Laboratories, Inc., will investigate feasibility of techniques using printed circuits and magnetic recordings for sonar use, under a $108,533 study contract from Navy's BuShips.

Elkton Division (Md.) of Thiokol Chemical Corp. has received a $492,000 contract from USAF for continued research on high-energy solid propellants.

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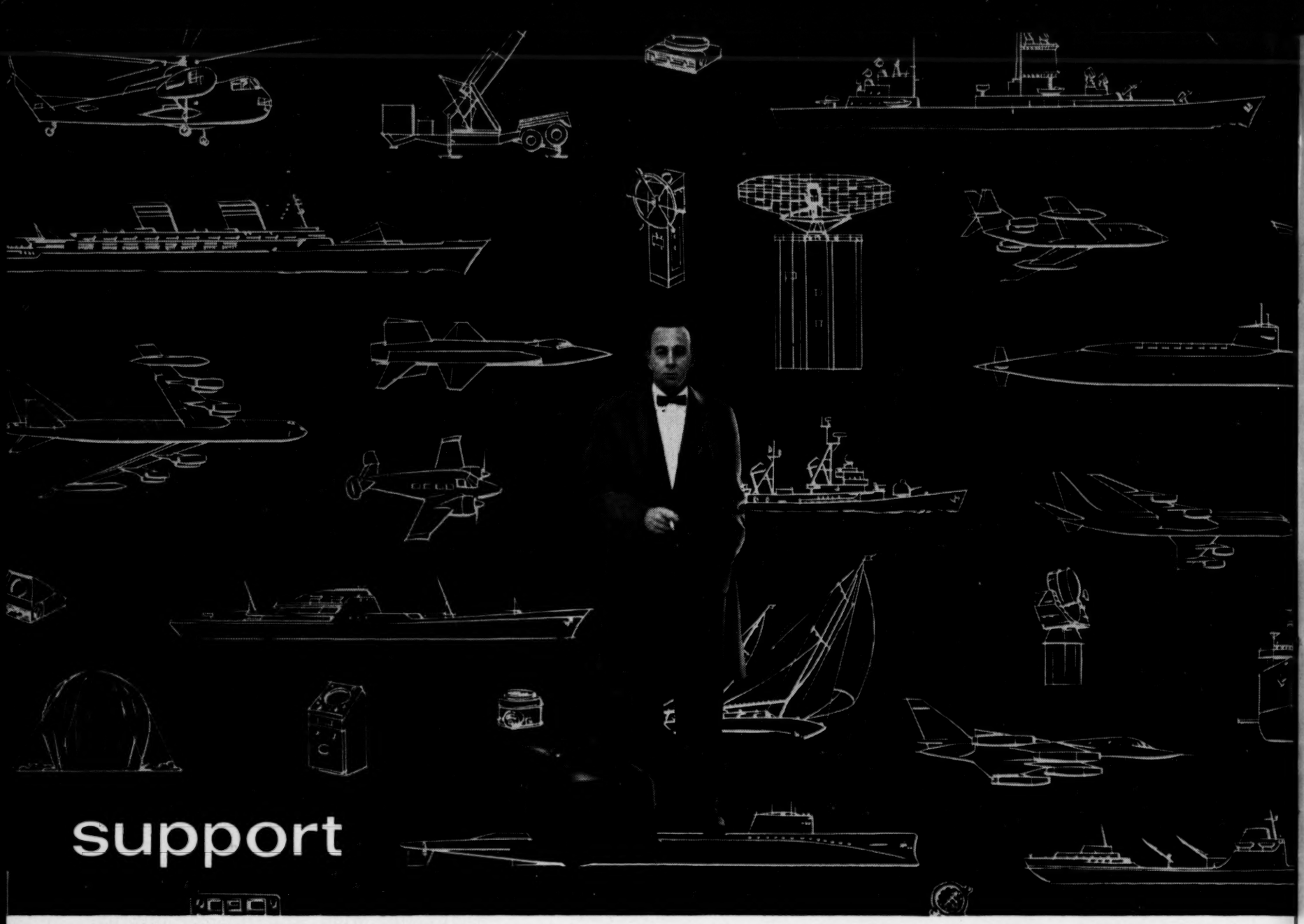

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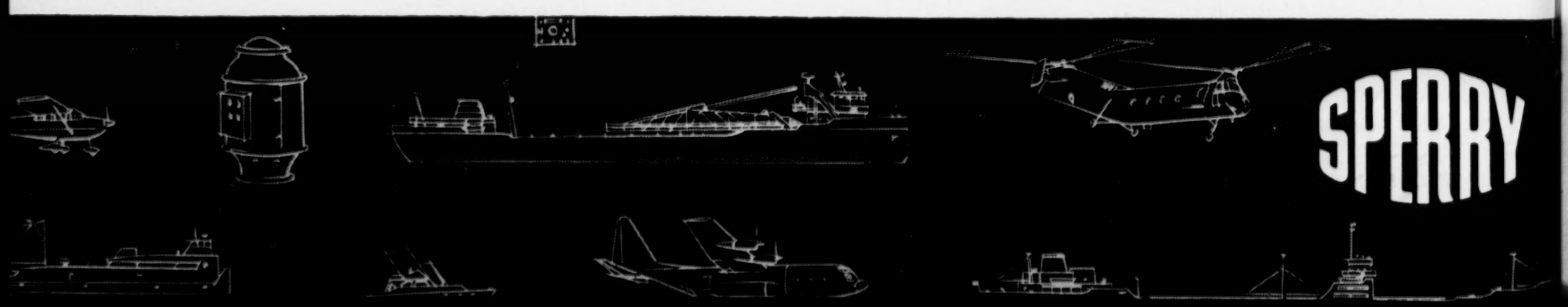


JPL Simulator Will Test Mariner A

By Irving Stone

Pasadena, Calif.—Space simulation chamber to evaluate ultimate designs of spacecraft under realistic environments will be completed by the end of the year at NASA's Jet Propulsion Laboratory here.

Mariner A, NASA's JPL-developed Venus flyby probe (AW June 12, p. 52) will be the first spacecraft tested in the new facility. Mariner A is 8 ft. high and spans 19 ft. with solar panels extended. First Mariner A flight is scheduled for late 1962.

The simulator is a cylindrical tower 80 ft. high and 27 ft. in diameter.

The lower part of the simulator contains a stainless steel vacuum chamber 47 ft. high and 25 ft. in diameter, for housing the spacecraft. A 10,000-sq.-ft. building containing a control room and equipment area will house the simulator. The upper portion of the simulator incorporates the solar simulation unit. Artificial sunlight is generated by 150 arc mercury xenon lamps, each using 2.5 kw and fitted with a 16-in. reflector.

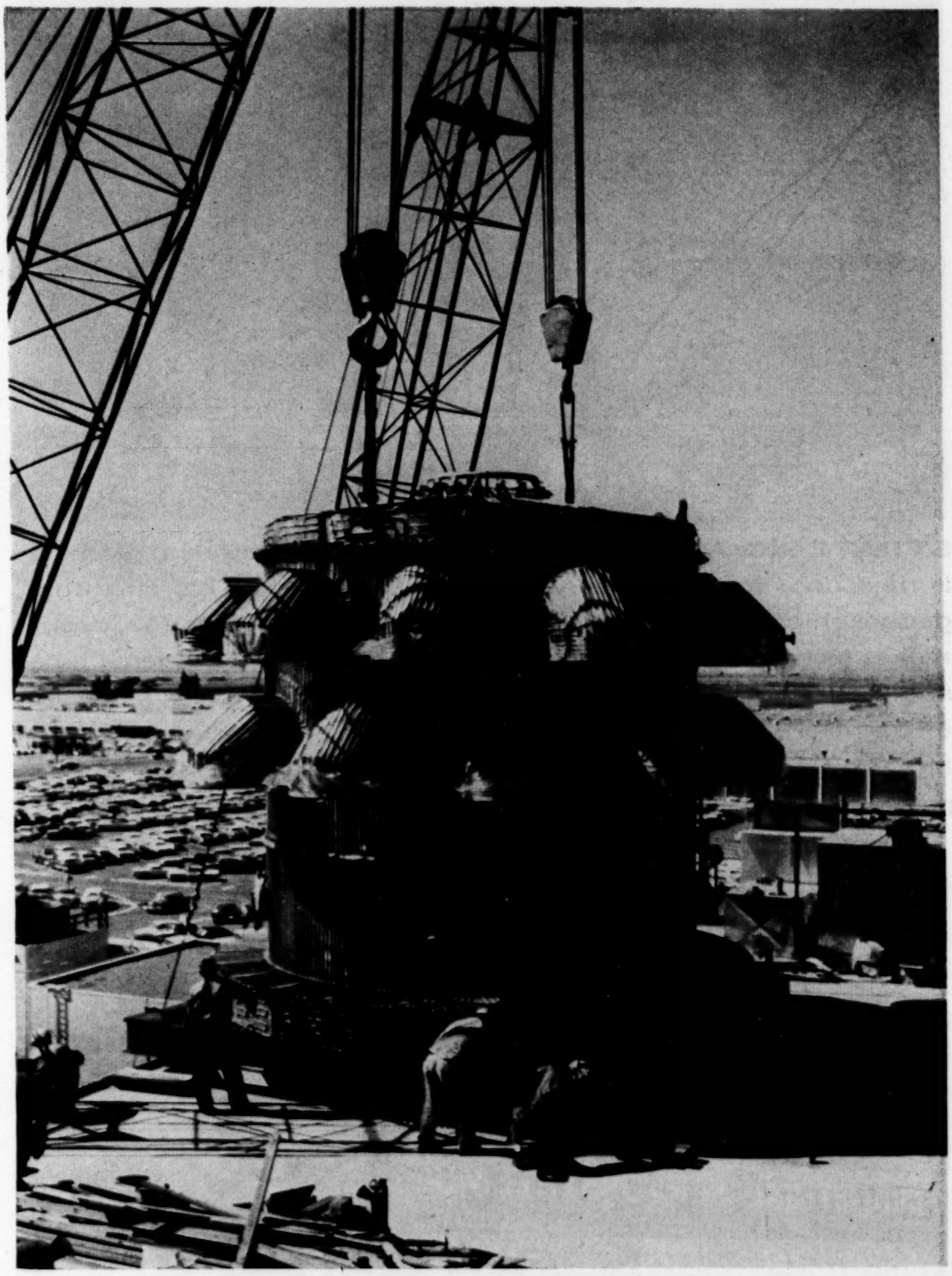
Light from the mercury xenon lamps shines down onto a parabolic mirror which reflects it up in a concentrated beam onto a hyperbolic mirror which, in turn, reflects the beam downward through a 3-ft.-dia. lens into the vacuum chamber. Inside the chamber the 3-ft. beam impinges on a 2.5-ft.-dia. mirror which reflects it up onto a parabolic mirror at the top of the cylindrical chamber. From this surface the light shines down onto the spacecraft in a collimated beam, similar to sunlight in space. Plans are to modify the system later to permit the projection of a 25-ft. beam.

Variable Lighting

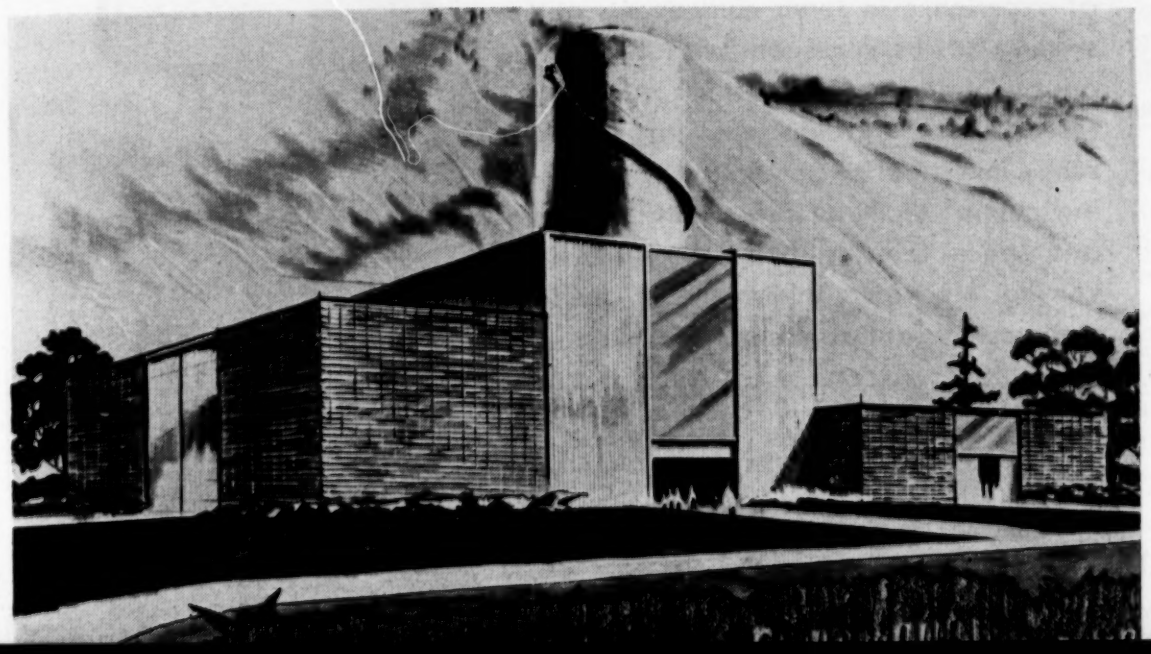
The lighting system will be variable to simulate sunlight intensity a spacecraft would encounter as near to the Sun as Venus or as far away as Mars.

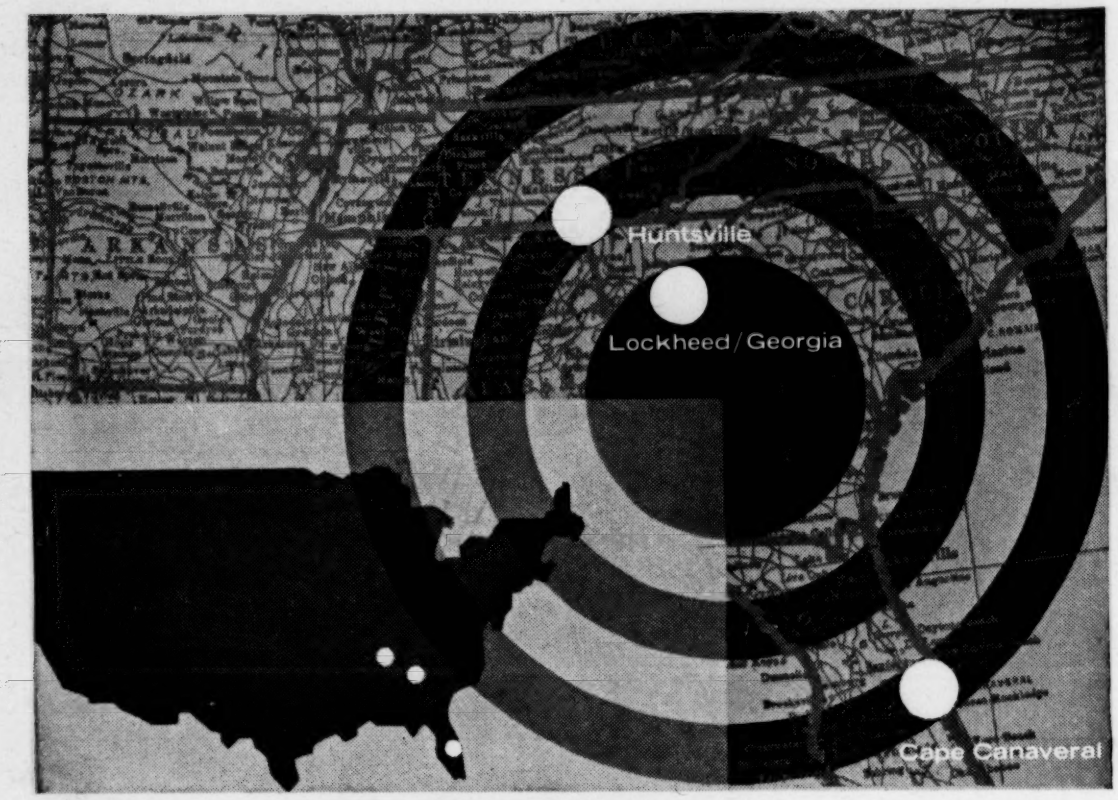
An aluminum shroud inside the chamber is composed of 200 plates finished dull black to absorb heat and cooled to minus 310F. Temperature is maintained by pumping liquid nitrogen through tubes running through the shroud. This system absorbs and carries away 99% of the heat radiated from the spacecraft. This design is in keeping with the philosophy that if the spacecraft is well designed it will absorb some of the heat projected onto it in space to keep its thermal balance near the optimum level, while the rest is reflected into the infinity of space.

The vacuum in the chamber is created with a three-stage pumpdown



JET PROPULSION LABORATORY-designed space simulation chamber (above) is lowered into place in new Space Simulation Facility at Pasadena, Calif. Artist's conception of the new building (below) shows tower for housing artificial sunlight system. Chamber, which weighs 55 tons, rests immediately below. Protrusions on chamber are ducts which will lead to vacuum pumps. Aluminum shroud inside chamber has 200 plates to absorb heat.





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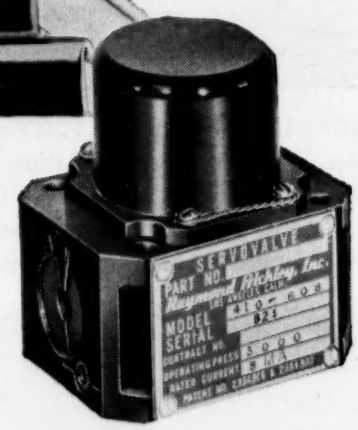

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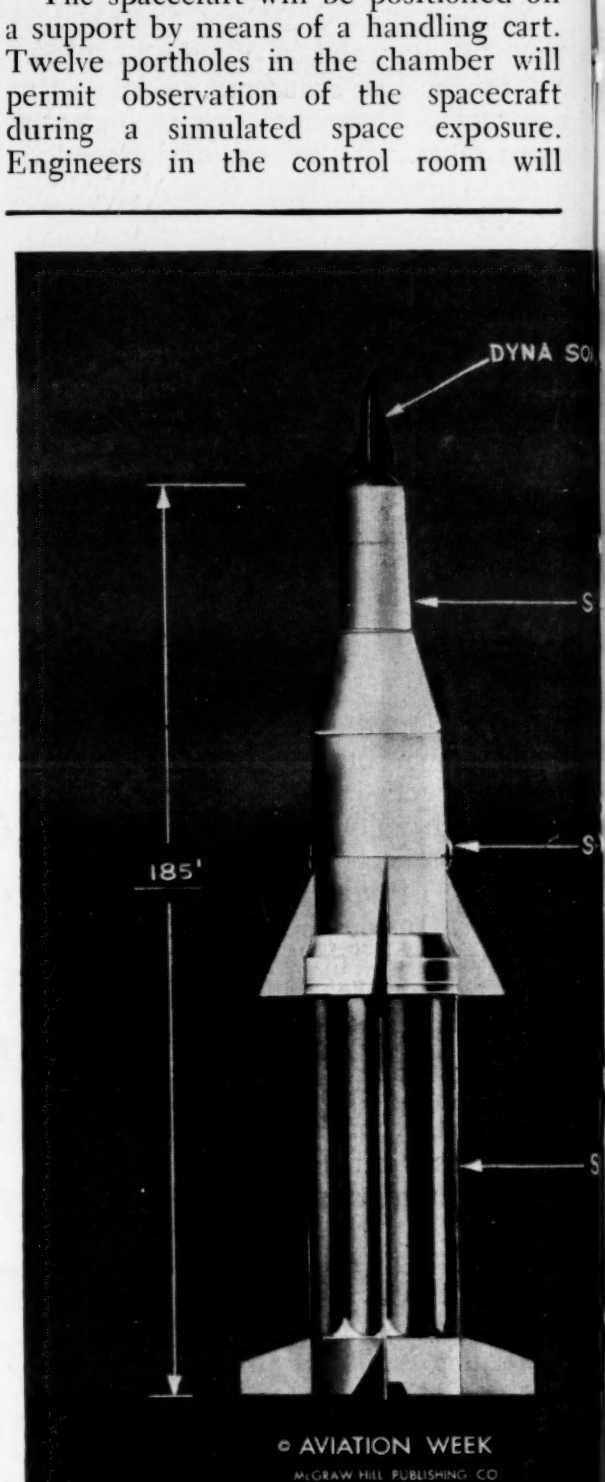
system. The first stage incorporates seven compressors, followed by a roughing system consisting of three vacuum blowers, which removes all but a small fraction of the initial air. Ten oil diffusion pumps finish the evacuation to produce a vacuum of .000001 mm. of mercury, about one-billionth of the atmosphere at sea level. The diffusion pumps are worked continuously during tests to remove outgassing or evaporation from the chamber.

The spacecraft will be positioned on a support by means of a handling cart. Twelve portholes in the chamber will permit observation of the spacecraft during a simulated space exposure. Engineers in the control room will



Dyna-Soar Study

Use of Saturn to launch the Dyna-Soar vehicle is under study using S-1 booster stage, S-IV second and S-V final stages. Boost phase control system might be modified to include fins or vanes on the first and second stage airframes. An orbital Dyna-Soar weapon system would be expected to weigh approximately 25,000 lb. with a body diameter of 7 ft. and a length of 17 ft. The S-V stage would be incorporated in the vehicle only if Dyna-Soar were used for earth escape missions.

He designs antennas for every purpose except this one

He's one of a staff of AMF engineers which has been designing and producing precision radar antennas and components since early in WW II. AMF's accomplishments reflect the team effort, enormous experience and complete fabrication capability made available for each project.

Here are highlights:

Fixed base—AMF's experience in designing automatic machinery was utilized in the 10,000-lb. AN/FPS-19, the famous "Dew Line" antenna, designed and built by AMF to operate unfailingly under fantastic arctic conditions.

Mobile—AMF designed and built AN/TPQ-10 precision tracking antenna that demounts into shock-resistant, immersible components. AN/MPS-4 and 16 are AMF-designed trailer and truck-mounted types.

Stabilized base—Design and fabrication of SX, AN/SPS-8B High Gain Antenna, AN/SPS-3 Dual Foster Scanner.

Precision pedestals, theodolites—AMF's Precision Instrument Mount is controlled by optical digital discs accurate to 0.05 milliradans. It tracks missiles and satellites.

Rotary joints—A special AMF capability requiring utmost precision in design. Example: multichannel joint for AN/FPS-24 System.

Scanners, Feeds, Servos and *Drives*, Multichannel Phase Shifters, Hydrostatic Bearings, Slip Rings, Programming, Test, Control and Display systems are all part of AMF's radar capabilities. AMF also operates its own test ranges.

For more information, write American Machine & Foundry Company, Government Products Group, 261 Madison Avenue, New York 16, N.Y.

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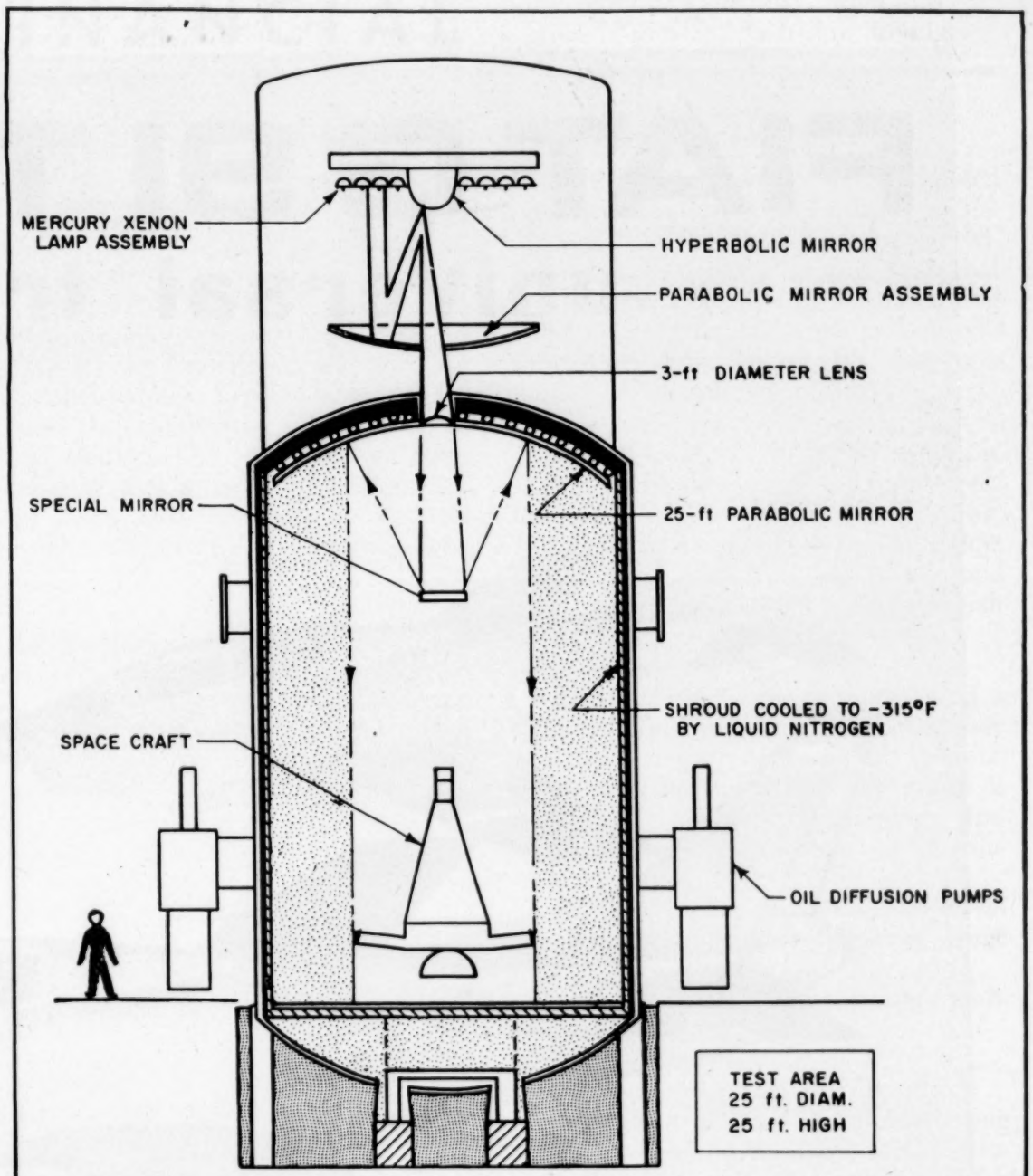

CUTAWAY DRAWING of the JPL space simulator shows arrangement of lighting system, vacuum chamber and liquid nitrogen-cooled shroud to simulate conditions of outer space.

monitor reactions, to the space environment, of the spacecraft's transmitting and receiving equipment, guidance and control systems, and instrumentation.

The simulator is being constructed by a team of industry companies headed by Consolidated Vacuum Corp., Rochester, N. Y. Team subcontractors include Aerojet-General Corp.'s Aetron Division (design of building, instrumentation and external cryogenics), Bausch & Lomb (design of solar simulation system), Tenney Engineering Corp. (internal cryogenics and power system for lights), and Pittsburg-Des Moines Steel Corp. (fabrication of vacuum chamber and assembly and erection of entire facility).

Centrifuge Can Test Multiple Specimens

Centrifuge for creep testing up to 32 specimens at once has been developed by Aerojet-General Nucleonics Division for the Atomic Energy Commission.

The centrifugal tester can operate at temperatures up to 2,000F and stress levels up to 500,000 psi. Strain can be measured while the machine is whirling. Strain sensitivity of the system is about a millionth of an inch of gage length. Specimens are stressed by the centrifugal effect upon their own mass and can be cut differently to permit tests at multiple stress levels simultaneously.

A miniature version will be delivered to AEC for creep testing inside a nuclear reactor. Some metals are weakened by radiation effects and the centrifugal tester will be able to obtain information about the creep strength of materials during irradiation. With more precise knowledge, it should be possible to reduce over-design safety factors that compensate for lack of data.

Data from in-pile tests have been limited in the past because only one or two specimens could be tested inside the reactor at one time. The large amount of reactor time needed for given amount of data resulted in high cost per specimen. The centrifuge should reduce it to a fifteenth of the present level. Aerojet claims the cost will be no more than that of three single-specimen conventional creep testers.

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Universal trainer capable of Carrying through pilots from the initial flight training to operational mission

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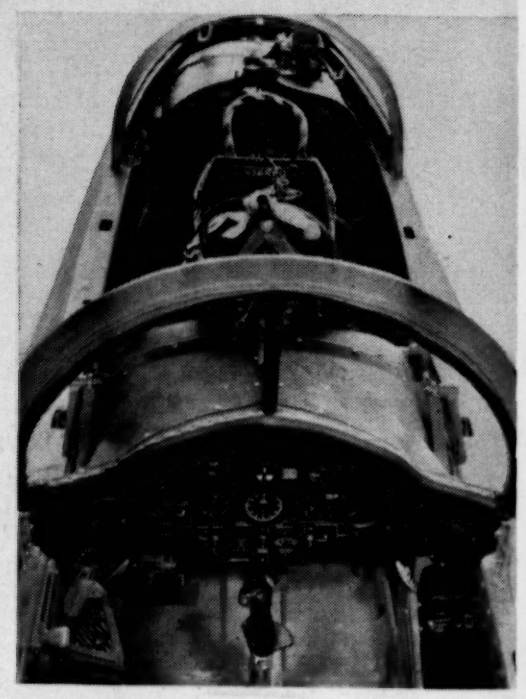
It preserves all the main features and possibilities of the single-seater and, therefore, can be used as an operational lightweight tactical aircraft.



Cockpit

FIAT - DIVISIONE AVIAZIONE
CORSO G. AGNELLI 200 TURIN (ITALY)

New Offerings

Hycon Manufacturing Co., Monrovia, Calif., principally engaged in the design, development, manufacture and sale of aerial cameras and photogrammetric instruments, electronic test equipment and communications equipment; substantially all its sales are made at present to various agencies of the federal government, including the Air Force, the Army and the Navy, or to companies engaged in work for such agencies.

Offering is 325,000 shares of common stock. Of this stock, 300,000 shares are reserved for issuance or were heretofore issued pursuant to stock options; the remaining 25,000 shares were acquired by the Gardner Corp. from L. D. Roberts on Sept. 15, 1960, for $57,500, and 2,500 shares were resold to Miss R. Frances Taylor, assistant secretary. Options for 275,000 shares are now outstanding, exercisable at $2.85 per share (except as to 6,000 shares which are exercisable at $4 per share). The shares being registered may be offered for public sale from time to time on the American Stock Exchange by the persons to whom the stock has been or may be issued, at prices prevailing on the Exchange at the time of offering. The company intends to apply the net proceeds of shares issued upon the exercise of options to its general funds.

Trevor Gardner, president and board chairman, and members of his family are owners of all the stock of Gardner Corp.

Paul Hardeman, Inc., Stanton, Calif.; organized under Delaware law in March, 1961, the company is the successor to a California company of the same name. In April, 1959, all of the predecessor's outstanding capital shares were acquired by Universal American Corp., in exchange for Universal's common stock. When the present company was organized all its outstanding shares were issued to Universal in exchange for those of the company's predecessor, which thus became a wholly owned subsidiary of the company until merged into it in March, 1961. The company engages primarily in the design, engineering, construction and installation of missile launching bases and related facilities for the armed forces, and complex facilities of various types for agencies and commissions of the United States government, and for the aircraft, petroleum, chemical and petro-chemical industries.

The offering is 350,000 shares of common stock for public sale; public offering price and underwriting terms to be supplied by amendment. Proceeds will be used for general corporate purposes, as working capital, in order to expand the size and scope of its business by enabling it to bid on more and larger contracts. In addition, such working capital will be used to pay indebtedness to Universal and to expand the company's activities in its actual construction projects, in commercial as well as military and government fields, and also may be used for the reduction of any outstanding bank loans.

Air Reduction Company, Inc., New York, N. Y., has filed a registration statement for 100,000 shares of common stock, to be offered to officers and other executive employes of the company pursuant to its 1957 Stock Option Plan.

Mergers and Acquisitions

Fairchild Stratos Corp. has acquired Tribo-Netics Laboratories, Vermillion, Ohio, which specializes in gas-lubricated bearings. Fairchild also acquired the assets of a Tribo-Netics affiliate, Advanced Precision, Inc.

Martin Co. and American-Marietta Co. boards of directors have reached agreement on a merger proposal to present to their stockholders. The merger would be accomplished through an exchange of stock. American-Marietta is a producer of building and household supplies and solid rocket fuel.

Gulton Industries, Inc., Metuchen, N. J. has acquired West Instrument Corp., Chicago, Ill., producers of precision temperature control equipment in a $2,800,000 transaction. Gulton specializes in materials research, electronics, components and systems engineering and related manufacturing. Acquisition involved the exchange of 43,804 Gulton common shares for all of West Instruments' outstanding shares.

Astro-Science Corp. of Culver City and Fullerton, Calif. has acquired the Ground Support Division of American Electronics, Inc., in a cash transaction involving more than $1 million. Newly acquired unit located in El Monte, Calif. will be known as Astro-Systems, Inc. and will be operated as a division of Astro-Science Corp.

Financial Briefs

United Aircraft Corp. has completed private placement of $75 million in 5% sinking fund notes. Chairman H. M. Horner had said earlier this year that United was considering a $50-million bond issue to replace some of United's short-term bank loans with long-term money (AW Feb. 13, p. 33).

Dynalectron Corp., Washington, D. C., is the new name voted by stockholders of California Eastern Aviation, Inc. The name change is said to reflect the diversified avionic, astronautic and x-ray interests of the company which is no longer an air carrier.

Sperry Rand Corp. has organized a Central Marketing Group to coordinate the marketing activities of the corporation's defense activities. The group is headed by Malbon H. Jennings, formerly marketing director at Ramo-Wooldridge.

The marketing group breaks down its activities into the following three categories:

- **Market research** and long-range planing.
- **Program coordination.**
- **Overseeing regional market offices.**

Formation of the Central Marketing Group follows on the heels of the creation of the Sperry Systems Group which handles over-all managerial and technical coordination between the firm's divisions, and personnel from the marketing group are scheduled to work closely with the company's systems organization.

Pacific Air Lines Plans Public Offering

San Francisco—Pacific Air Lines, Inc., a local service carrier with routes in California, Oregon and Nevada, plans a public offering in August of $108 million of 6½% convertible subordinated debentures and 180,000 shares of its common stock par value at 50 cents per share.

The securities will be offered only in packages of debenture plus stock. Each package will consist of debenture principal of $100 and 10 shares of common stock.

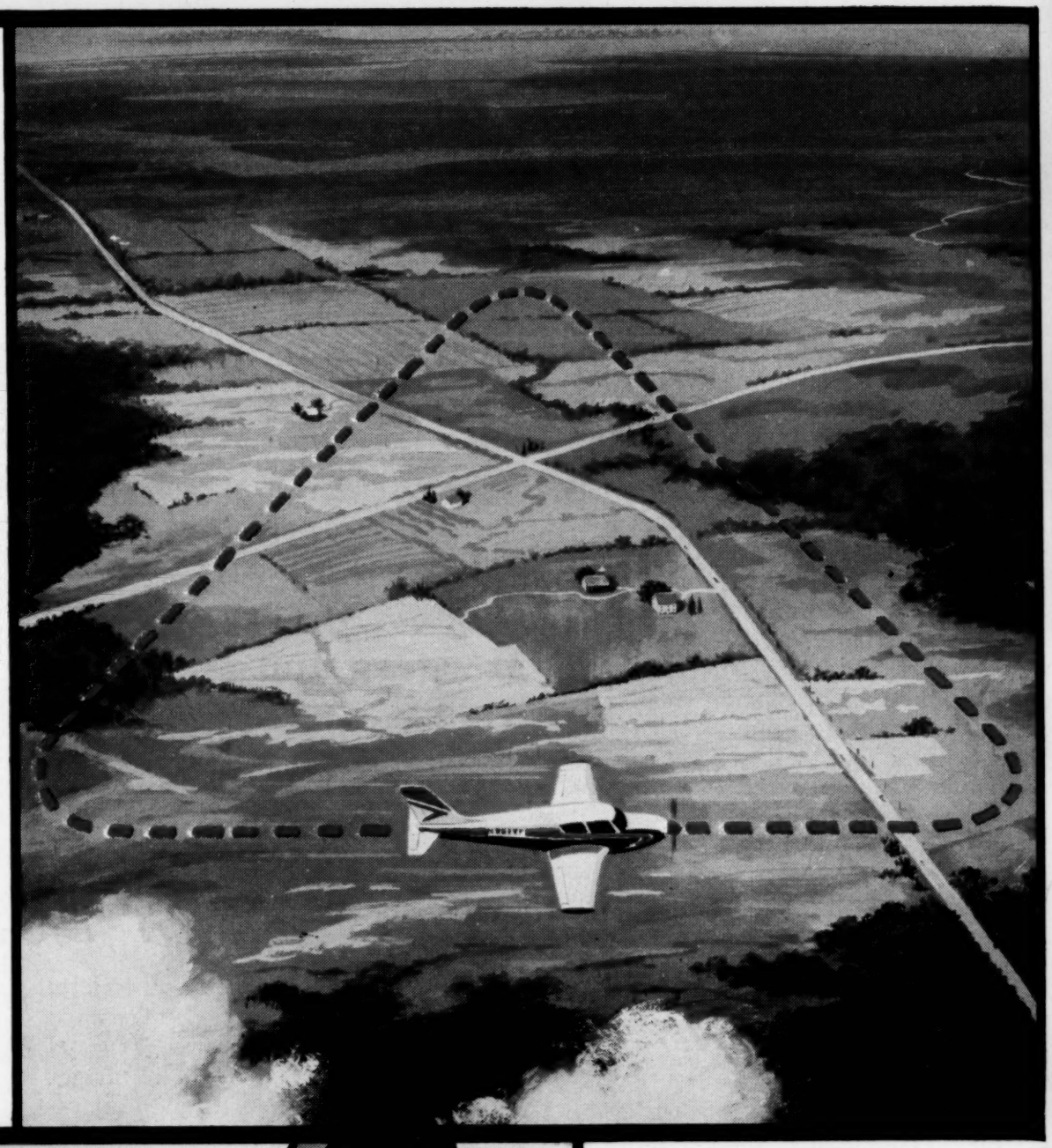
Package cannot be separated until January, 1962.

Company will use proceeds from securities sale to pay indebtedness incurred by it in purchase of new aircraft and engines, remodeling and modernizing these planes, and for general corporate purposes.

WING TIPS

WHEN LOST IN FLIGHT —EMERGENCY PROCEDURE

If you're ever lost, here's what to do: WITH RADIO CONTACT: Tune to emergency frequency 121.5 mc. Fly a triangular pattern to the right in 2 minute legs with 1½° per second turns of 120°. Complete a minimum of two patterns before resuming course. If radar contact is established, instructions will be given on 121.5 mc. NO RADIO CONTACT: Fly a triangular pattern to the left in the manner described above. If radar contact is established, a Search & Rescue plane will be dispatched for interception. Resumption of course will not compromise this system as your plane will continue to be tracked as "distressed" from the point of initial radar contact. If possible, repeat the procedure each 20 minutes until instructions are received or interception by Air Rescue Service is accomplished.



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THIRD PROTOTYPE of first postwar German turbine-powered helicopter, the SM 67, is built by Merckle Flugzeugwerke GmbH.

SM 67 Completing Initial Flight Trials

By Edith Walford

Oedheim, Germany—Third prototype of the five-seat SM 67 helicopter built by Merckle Flugzeugwerke GmbH. and representing Germany's first turbine-powered rotary wing aircraft, is now completing its initial flight tests here.

The company began development of the SM 67 in 1956 as a privately financed, independent venture. Subsequently, the West German Defense Ministry became interested in the project, and provided it with financial support.

First prototype, a utility version with a welded steel tube fuselage, flew in July, 1959, but was severely damaged during ground tests the following month (AW Sept. 14, 1959, p. 72).

The second model, completed toward the end of 1959, and incorporating several modifications, has remained an experimental aircraft.

The present third prototype SM 67 is powered by a Turbomeca Artouste 2C engine rated under standard conditions at 493 eshp. It replaces the Turbomeca Artouste 2B turbine rated at 396 eshp., which powers the experimental SM 67 version. The engine is fitted with an automatic independent speed regulator, which keeps the rotor speed constant even though the engine power may be reduced. It also eliminates the use of a hand-operated throttle lever, which is often tiring for the pilot.

The steering unit has a hydraulic power amplifier to reduce vibration on the control stick.

Rotor Head

The rotor head is fitted with interchangeable metal blades constructed to Merckle's own design. Both the load-carrying parts and the outer skin of the helicopter are of lightweight bonded metal construction to avoid voltage peaks, increase durability and offer an aerodynamically more favorable, smooth surface. Room is provided for optional de-icing equipment.

The SM 67 is a multi-purpose helicopter. Standard version is a pilot-plus-four-passenger configuration for business flying and touring. Equipment is available to adapt the aircraft to a wide variety of additional uses such as a trainer with dual controls, as an ambulance capable of carrying two stretchers and a medical attendant in addition to the pilot, for agricultural, topographical or cargo-carrying duties.

Design of the welded steel tube framework of the fuselage is aimed at increasing the helicopter's performance in both forward and hovering flight conditions. The four-door plastic-glass cabin allows an unobstructed, all-round view. The main rotor assembly, gear unit, powerplant, fuel tanks and land-

MERCKLE SM 67 five-seat helicopter is powered by a Turbomeca Artouste 2C engine rated at 493 eshp. It is seen here shortly after takeoff on its initial flight on Apr. 12.

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SM 67 Specifications

Seating capacity: 5
Powerplant: . . 1 Turbomeca Artouste 2C
Turbine speed . . . . . 34,000 rpm.
Maximum power output . . . . . 406 hp.
Cruising power output . . . . . 330 hp.

Dimensions:

Span including rotor . . . . . 41.82 ft.
Height . . . . . 9.18 ft.
Width of fuselage . . . . . 5.00 ft.

Rotor:

Number of blades 3
Rotor diameter . . . . . 34.4 ft.
Rotor speed at maximum power . . . . . 335 rpm.

Tail rotor:

Number of blades 2
Rotor diameter . . . . . 6.56 ft.
Elevator unit: adjustable fin without rudder
Rudder assembly: fixed fin without rudder
Landing gear: two main skids, one tail skid

Weights:

Empty weight . . . . . 2,280 lb.
Useful load . . . . . 1,460 lb.
Gross weight . . . . . 3,740 lb.

Performance: (est.)

Top speed (406 hp.) . . . . . 130.4 mph.
Cruising speed (330 hp.) . . . . . 118 mph.
Rate of vertical climb (406 hp.) . . . . . 19.35 fps.
Rate of inclined climb . . . . . 29.5 fps.

ing gear are located in the middle of the fuselage—elevator, rudder unit and tail rotor in the rear fuselage section.

The pilot and one passenger sit side-by-side in the two front seats of the cabin; the three other passengers sit side-by-side immediately behind the front seats. There also is room in the cabin for a limited amount of baggage. By removing the three rear seats, the helicopter can accommodate two stretchers for rescue work.

The illuminated instrument panel is installed so as not to interfere with the pilot's view and provision is made for dual controls. A combined pressure-type air conditioning and cabin heating system is installed and fire extinguisher and first-aid kit are accessible both from within and from outside the cabin. A soundproofed firewall screens the cabin from the power unit. Partly detachable metal cowling with flaps afford easy access to the powerplant and steering unit. The rear fuselage section is half covered with a lightweight metal skin.

The rotor head is fitted with three rotor blades. Centrifugal force is relayed over an assembly of torsion bars to stabilize flight. Blade damping is operated hydraulically, and the blade joints have front and rear backstop fittings to limit or adjust their stroke.

Rotor blades, are of lightweight bonded metal construction. They are detachable and the profile is constant throughout the entire blade length.

Both the adjustable elevator unit and the fixed rudder assembly are of lightweight metal construction.

The semi-rigid anti-torque tail rotor has two steerable metal blades attached to the miter gear on the rudder assembly and is actuated over another miter gear in direct fixed pitch transmission by the main rotor.

Landing gear consists of two skids supported by two flexible cross bars attached to the middle section of the fuselage. The cross bars and the hydraulic damping assist in cushioning normal landings. Four fitted flexible struts increase the resilience of the landing gear in case of a hard landing. Two retractable wheels serve to transport the helicopter on the ground.

A flexible tail skid affords good ground clearance of the tail rotor during a pull-out of the helicopter of up to 30 deg.

The steering unit has a hydraulic power amplifier to modify the force of the control stick and eliminate any turbulence. The helicopter can also be mechanically controlled should the hydraulic amplifier cut out. The steering unit is attached to the stick and control pedals the same as on any other aircraft. An additional pitch control lever serves to adjust all rotor blades through the control stick amplifier.

Argentina Ordering 81 Rallye Aircraft

Paris—Argentine government's order for 81 Morane-Saulnier Rallye sportsplanes has pushed the French company's Rallye order backlog over the 500 mark.

Argentine order was signed by the State Arsenal, Dinfia, last month. Details recently released reveal that the contract calls for one completed aircraft, 10 in large assemblies and the balance in component parts. Dinfia will also handle Rallye sales in Argentina.

In mid-June Morane had booked 514 Rallye orders of which 365 represented sales in 27 foreign countries. Bulk of the orders are shared almost equally by the 100-hp. Super Rallye and 145-hp. Rallye 885. Only 10 orders have been placed for the 90-hp. Rallye model.

In September, Morane intends to bring a Super Rallye to the U. S. for demonstration flights. This visit, originally scheduled for May, was postponed following a washout accident on the 02 Rallye prototype. French company, incidentally, is still seeking a partner for its U. S. sales effort.

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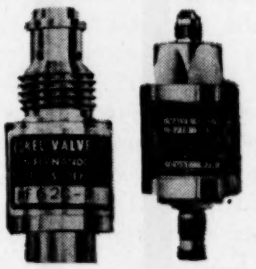
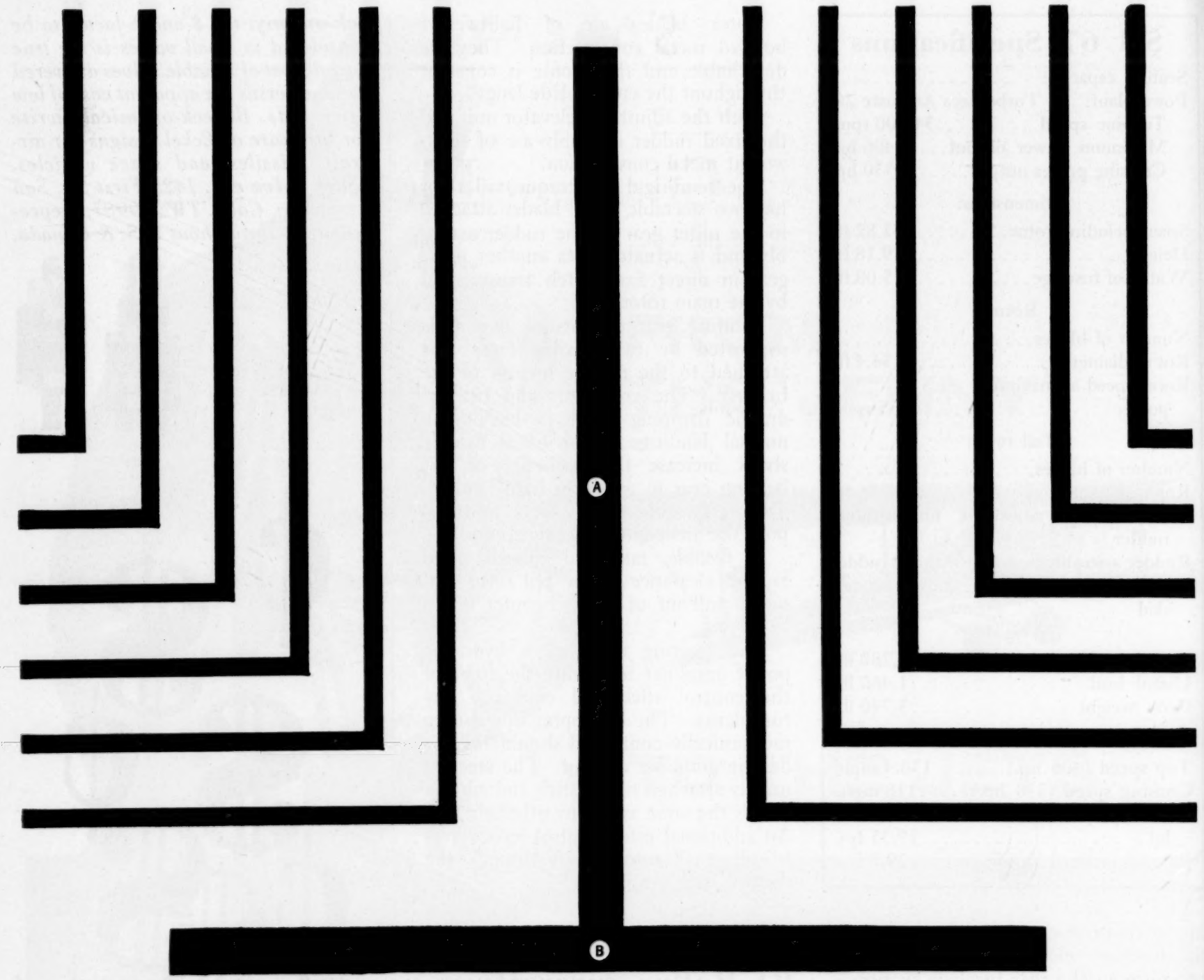
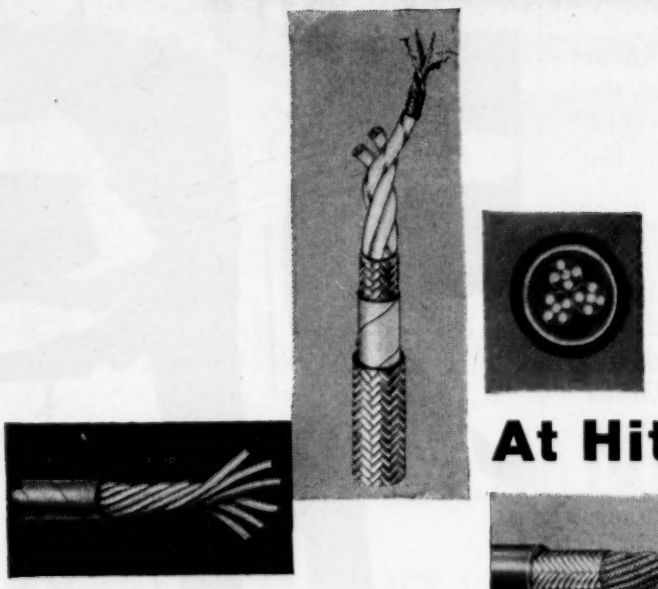




Are lines A and B the same length?



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CAB Accident Investigation Report—Part II:

Prior Damage Cited in Electra Crash

(This is the second and concluding part of the CAB accident investigation report on the crash of a Lockheed Electra L-188C near Cannelton, Ind., on Mar. 17, 1960. The first part, which appeared in the July 10 issue of AVIATION WEEK, *included the history of the aircraft and of the flight, the weather conditions present at the time of the accident, the report of eyewitnesses, a discussion of the wreckage distribution and post-accident condition of the aircraft structures, powerplants and subsystems.)*

To obtain a type certificate for a fixed-wing airplane, which has a weight in excess of 12,500 pounds, compliance must be shown with the provisions of Part 4b of the Civil Air Regulations. As a general rule the provisions of that Part which are in effect on the date of application for a type certificate are the regulations applicable to the type. In the case of the Lockheed Aircraft L-188, application for type certification was made on November 11, 1955, with the result that the applicable airworthiness regulations were contained in Part 4b effective December 31, 1953, and Amendments 4b-1 and 4b-2 of that Part.

In addition to the specific requirements contained in Part 4b, Section 4b.10 of that Part states that an airplane shall be eligible for type certification if it complies with the airworthiness provisions established by the Part or if the Administrator finds that the provisions not complied with are compensated for by other factors which provide an equivalent level of safety. This section also requires the Administrator to make a finding that no feature or characteristic of the airplane would render it unsafe for the transport category.

Special Conditions

Since the turbine-powered airplanes, at the time of this application, were still in the design stages. the Civil Air Regulations did not encompass airworthiness requirements specifically applicable to the unique design of these airplanes. Accordingly, the Civil Aeronautics Administration developed a set of special conditions to be applicable to this airplane type. The special conditions were developed through the activities of a Turbine-Powered Transport Evaluation Team composed of employees of the Civil Aeronautics Administration. During the certification process numerous amendments were made to Part 4b of the Civil Air Regulations which included many of the applicable special conditions to the L-188. On July 23, 1957, the Civil Aeronautics Board adopted Special Civil Air Regulation Number SR-422 which became effective on August 27, 1957. This special regulation contained a revised set of performance requirements for turbine-powered airplanes and made applicable the provisions of Part 4b of the Civil Air Regulations effective on the date of application for type certification together with such provisions of all subsequent amendments to Part 4b, in effect prior to August 27, 1957, as the Administrator of Civil Aeronautics finds necessary to insure that the level of safety of such airplanes is equivalent to that generally intended by Part 4b.

In view of Special Civil Air Regulation Number SR-422, the Civil Aeronautics Administration amended the set of special conditions applicable to the Lockheed L-188 to incorporate those provisions of Part 4b in Amendments 4b-3, 4b-4, and 4b-6 which were comparable to those specific special conditions previously established by the Administrator, as well as the performance requirements contained in SR-422. Those special conditions which were not incorporated in the aforementioned amendments were retained.

In order to monitor and approve the type certification of aircraft the Civil Aeronautics Administration established Regional Offices throughout the United States. In the case of the Lockheed L-188, Region IV was responsible for determining that the airplane type complied with the Civil Air Regulations and the applicable special conditions. For many years the Civil Aeronautics Administration has utilized a designee system to assure compliance with the Civil Air Regulations. The establishment of this system was due to the limited number of personnel available in the CAA's field offices. Under this system designated employees of the applicant are delegated to approve certain data, drawings, etc. The approval of the basic data and method of analysis was retained by the Civil Aeronautics Administration, but the actual analysis of the data was approved by the designees and reviewed by the Administrator. The only area of the certification process where designees are used quite sparingly is in the flight test area. In almost all cases the flight tests were conducted by Civil Aeronautics Administration employees.

On August 22, 1958, the Civil Aeronautics Administration issued type certificate No. 4A22 approving the Lockheed L-188A-08, and L-188C type airplanes.

Structural Difficulties

Subsequent to the delivery of the first few airplanes, Lockheed Aircraft conducted a flight test to determine the characteristics of a mechanical disconnect for the flight control boost system at the design dive speed of 405 knots. This flight test was conducted on October 31, 1959, and consisted of diving the airplane from cruise altitude with various boosters disconnected. On the second dive, with the speed maintained at or slightly below the speed for limit Mach number, turbulence was encountered; the speed was dropped off 6 to 8 knots. After passing through the turbulence a fuel leak was observed from under the right wing. Ground inspection disclosed that the main damage was halfway betwen Nos. 3 and 4 engines. This consisted of some rivets with missing heads from which fuel was leaking; in addition, there was a shallow buckle near the rear beam just inboard of the No. 4 nacelle The nature of the wing damage and subsequent inflight measurements indicated that the failure was due to high wing torsions.

As a result of this difficulty, the airplanes already delivered were speed-restricted until a fix could be designed and installed. The resulting fix consisted of reinforcing the wing between the inboard and outboard nacelles.

During the original certification of the Electra the airplane was equipped with Allison engines and Aero Products propellers. Certification included a vibratory stress survey of the propellers. It was determined, based on past experience, that the inboard propellers were the more critical and only the inboard propellers were instrumented. Later a Hamilton Standard propeller was installed on the airplane and a new certification was sought. At this time it was decided to conduct the vibratory stress survey on one outboard and one inboard propeller. As a result of this test it was found that the outboard propellers were more highly stressed than the inboard propellers and that these stresses exceeded acceptable levels. This condition was caused by a higher than anticipated inflow angle due to a downward torsional bending of the wing with increasing speed. Outboard propeller blade stresses were reduced satisfactorily by reworking the nacelles to provide a 3 degree uptilt of the propeller plane. Inboard nacelles were similarly modified to reduce cabin noises and vibrations.

Impact Stresses

Difficulty was encountered on the Electra airplanes with impact stresses during landing which caused cracks in the milled wing skin both outboard and inboard of the inboard nacelles and loosening of the fasteners attaching the upper and lower wing panels to the main landing gear ribs. As a result, Lockheld issued Service Bulletins 306 and 337 which required the installation of a doubler outboard and inboard of each inboard nacelle on the upper wing surface respectively.

In addition, difficulty has resulted from overpressurization of the fuel system. In one case where foreign material was in the fuel manifold system the fuel inlet valve was held in the open position after the tank was filled. Consequently, structural deformation of the wing resulted and an inspection of all fuel manifolds was conducted. Lockheed believes that if the correct procedures are followed during the refueling operation such failures will not occur.

On March 20, 1960, the FAA issued, as a temporary measure, an emergency airworthiness regulation which reduced the Electra V_{no} from 324 knots CAS to 275 knots or 0.55 Mach. Following a meeting on March 22 with representatives of Lockheed, Allison (GMC), Electra operators, NASA, and CAB,

TO THE EDGE OF SPACE...

AND BACK

Northrop's Q-Ball, "hot nose" for the X-15, provides flight angle data to the pilot during the critical exit and entry phases of the history-making flights to the edge of space. This permits him to correct his angles of attack and sideslip to avoid the intense frictional heat limits. Q-Ball was developed by the Nortronics Division of Northrop under contract to the National Aeronautics and Space Administration.

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A DIVISION OF
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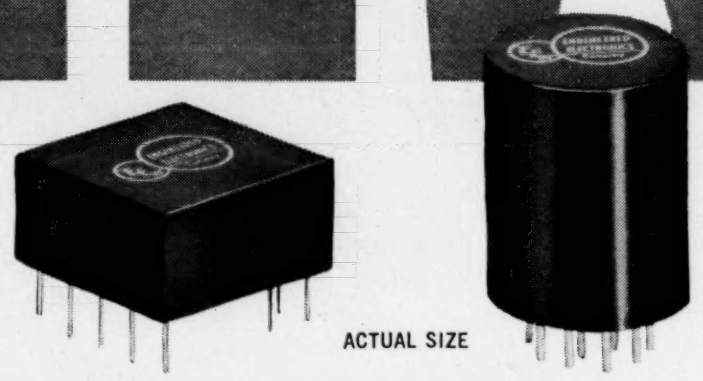
NEW



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FAA took the following additional action:

• **Because this and a previous** Electra accident were believed to have occurred at or near a cruising speed of 275 knots CAS, it was considered necessary to make a further speed reduction to provide an adequate safety margin. Consequently, a second emergency airworthiness regulation was issued on March 25, 1960, limiting V_{no} to 225 knots CAS or 0.55 Mach and establishes a V_{ne} of 245 knots CAS or 0.55 Mach. Also included in this second regulation were requirements calling for immediate propeller feathering if the torquemeter indicator registered zero or full scale; deactivation of the autopilot until appropriate modifications could be designed and installed; adherence to Lockheed prescribed procedures in refueling operations.

• **Under emergency authority specified** in Sections 40.21, 41.1, and 42.5 of the Civil Air Regulations, the FAA, in an amendment to the Operations Specifications, ordered a one-time inspection on all Electras within 30 days of the order date, March 25, 1960. The inspection included, in addition to the severe turbulence inspection specified in the Lockheed Structural Repair Manual, an internal examination of the entire wing with emphasis on wing ribs for damaged attachment tabs, buckled rib braces, loose or sheared rivets, and damaged or cracked clips. Additionally, a thorough inspection of the elevators, elevator tabs, and related attachments was also required during the same 30-day period. The amended Operations Specifications further called for daily inspections of powerplant magnetic sump plugs; inspection of fuel tanks involved in a reported tank overpressurization; structural inspections following any reported incidents of flight through severe turbulence, hard landings, or overweight landings.

• **On March 25, 1960,** the FAA notified the Chiefs, Flight Standards Divisions, that observance and surveillance of L-188 aircraft en route operation and training was to be increased for a period of 30 days. The telegram specified that inspections should be concentrated in the areas of flight planning, preflight, placard speeds, operating techniques, inadvertent entry into turbulence, abnormal equipment operation, post flight activities, and flight training.

On March 25, 1960, following several meetings in which the Electra problem was discussed, the Administrator requested the Lockheed Aircraft Corporation to conduct an engineering reevaluation of the Electra. The objective of this program was to reveal any design or operational characteristics of the airplane causing structural effects more critical than those provided for and possibly influencing disintegration in flight. Briefly, the program encompasssed flight tests, structures investigations, aerodynamics investigations, design studies and special investigations, and tests. Extensive assistance was provided by NASA, Boeing, Douglas, and other organizations in carrying out this program. A like program, appropriate to the equipment, was also carried out with respect to the engines and propellers.

Included in the flight test program were expanded measurements of wing and nacelle loads and stresses during smooth and abrupt maneuvers, measurement of the dynamic response of the wing and nacelles during gusts, extension of flight flutter response tests, expanded measurements of internal loads and

stress distribution in the wing and nacelles, and re-analysis of inflight loads measurements made prior to the accident.

Numerous stiffness and rigidity tests were made on Electra serial No. 1077 for use in flight dynamics analysis. Primary attention was directed to component rigidities from the outboard propeller plane through the engine, nacelle, and wing to the fuselage centerline. The effects of simulated failures at various points in the outboard engine/nacelle installation were measured, but not at any point in the wing structure itself.

In re-evaluation of the airplane control system and autopilot characteristics, special attention was directed to the influence of possible malfunctions, failures, and induced effects on the sudden buildup of destructive control forces. The investigation included both analytical methods and the use of an elevator system functional mockup. A rigorous series of tests was conducted on the mockup to induce oscillatory or other performance failures under extreme simulated failures and malfunctions in the system. Nothing was found that might have produced a hazardous situation under the flight conditions of the subject aircraft.

Procedures Review

A comprehensive review was made of all strength analysis procedures covering methods of determining internal loads, allowable strengths, and margins of safety. In addition to review of the original analysis, refined procedures were applied to the wing, wing rib, and wing beam analyses. In addition, the effect of damaged ribs on other rib loads and on the rigidity and strength of the wing was computed. Since the QEC structure had previously been static-tested to ultimate strength, attention was focused on changes in the design loads imposed.

Re-investigation of the structural loads was performed in regard to the following: wing loads in maneuvers, wing loads due to gusts, landing loads, and loads produced by autopilot malfunctions. Loads and stresses determined in the above-mentioned flight tests were used extensively in this program.

Re-audit of the flutter characteristics was divided into two areas of analysis and test. Analytical solutions were obtained by two independent processes of analog and digital. In the latter, 59 degrees of freedom were used. Wind tunnel tests were conducted on three different models. The first consisted of a nacelle-propeller model in the Lockheed 8-by-12-foot tunnel in which stiffness in pitch and yaw was varied over broad ranges. The second was an eighth scale half-span dynamic model of the wing with nacelles and propellers. This was tested in the Lockheed tunnel with varying engine-propeller stiffness and variations in wing fuel quantity. The third, an eighth scale model of the complete airplane, was tested in the NASA 19-foot Langley tunnel. More complete variations of engine-propeller stiffness and damping and wing fuel distributions were covered. In addition, the effects of propeller overspeeding were investigated.

The re-evaluation program disclosed two discrepancies in the design of the airplane. One of these was that significant loads imposed on the wing intermediate ribs between the fuselage and outboard nacelles by shell distortion had not been included in the design loads. The other was that the dynamic response of the outboard nacelles in turbulence was different from that used in the original design, with the result that the torsional loading of the wing inboard thereof was increased. In addition, the re-evaluation program disclosed that with the stiffness of a powerplant-nacelle installation reduced below normal, propeller oscillations could become destructive at the operating speed of N 121US at the time of the accident.

A study of the operational aspects of Flight 710 leads to certain definite conclusions. The flight was being conducted in accordance with company procedures, the filed flight plan was being closely followed, and up to the time of breakup all checkpoints had been reported approximately as estimated. In this segment of the investigation nothing was found which would produce a clue as to the cause of the accident.

Meteorological Evidence

Examination of all the meteorological and operational evidence at hand reveals that at 18,000 feet in the vicinity of Cannelton, Indiana, the aircraft concerned was operating in an area devoid of clouds with the following significant meteorological characteristics:

- **Just to the east** of a marked trough line.
- **Beneath and on the northern** edge of a jet stream with high velocity southwest-northeast flow (increasing with height) at all levels from the surface to the jet stream.
- **Marked horizontal** and vertical wind shear.
- **Pronounced horizontal thermal** gradient and potentially unstable lapse rates.

The above summary is derived from ground-based meteorological observations and a substantial number of pilot weather reports.

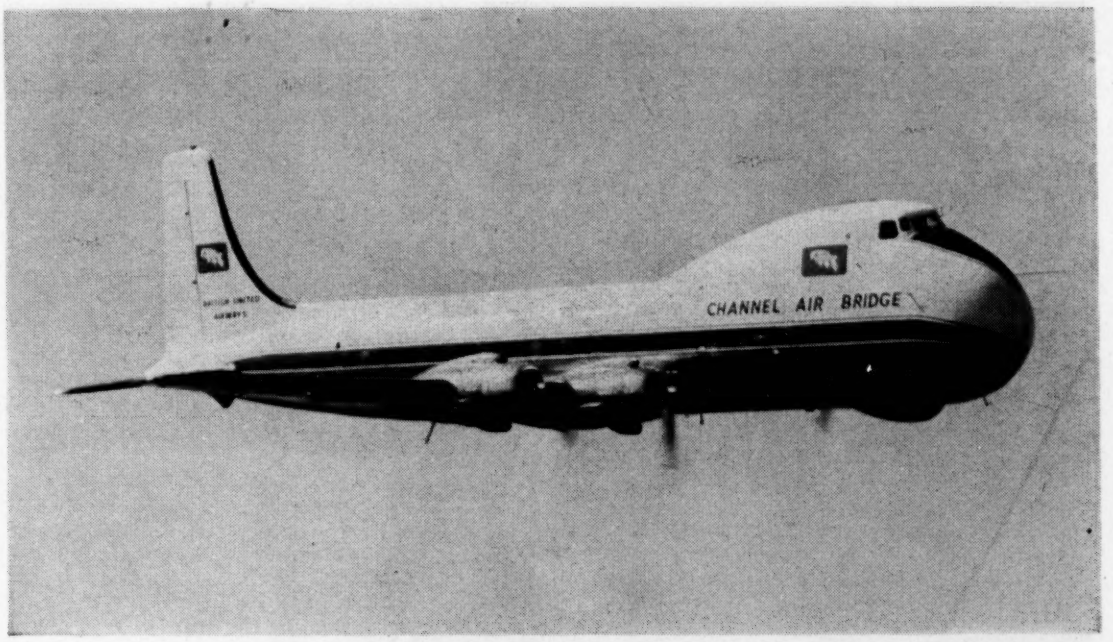
The above factors and the magnitude of each clearly indicate that severe clear air turbulence was highly probable at the time and place of the accident. Pilot weather reports of actual clear air turbulence encounters on that date likewise afford information substantiating the above conclusion.

After observing and forecasting a wind field embodying widely recognized meteorological factors utilized in the forecasting of clear air turbulence, the Board believes that the responsible offices of the U. S. Weather Bureau and Northwest Airlines should have mentioned clear air turbulence in their forecasts.

Three separate and independent studies of the clear air turbulence situation as it relates to this accident have been carried out by agencies other than the CAB (Weather Bureau, New York University, and Meteorology Research, Inc.). The conclusions reached in these studies are in exceptionally good agreement and support the conclusion of the Board's own study as summarized above.

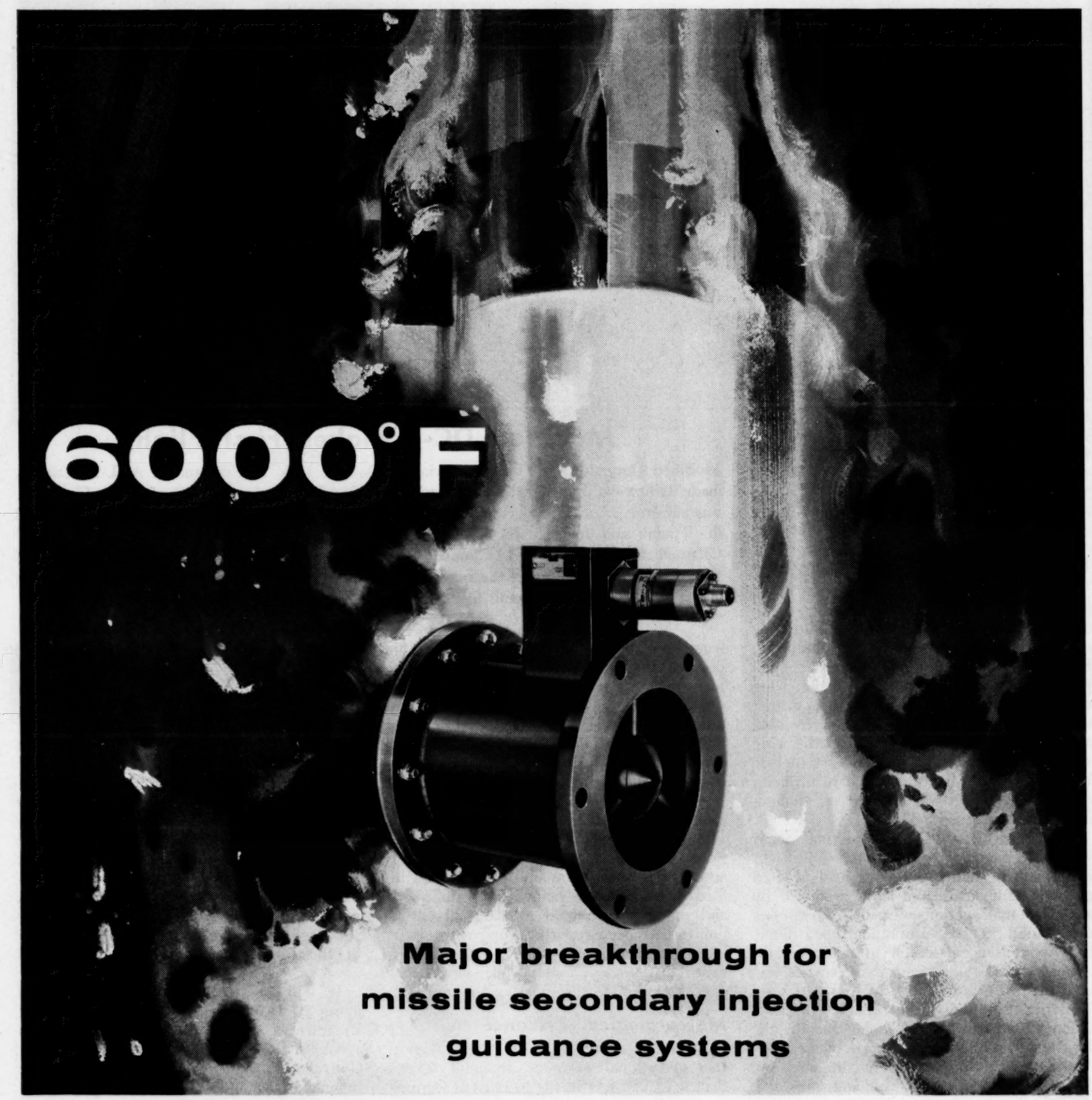
It will be recalled that certain pilots flying at 31,000 feet observed a horizontal streamer of smoke extending southward to a smoke cloud with corkscrew-shaped base. Considering the characteristics of clear air turbulence as opposed to convective turbulence, it is not difficult to understand the persistence of a relatively well-defined smoke column.

Trajectory studies of pieces of the aircraft wreckage indicated possible differences in sequence of separation, particularly in regard to light pieces, depending on assumed variables. However, the studies indicated as most probable that the aircraft was in level flight at an altitude of 18,000 feet, and a true course of 170 degrees at an indicated airspeed of approximately 260 knots during the disintegration. This analysis indicates that the first parts to separate were pieces of the right wing upper surface just outboard of the fuselage and that the powerplant and wing disintegrations took place within a period of six to 10 seconds. Disregarding the calculated results involving light pieces and extremely short differences in items of separation, the trajectory analysis indicates also that separations of the left outboard powerplant installation and the left outer



Modified DC-4 Makes First Flight

Modified Douglas DC-4, built by Aviation Traders, Ltd., and designated ATL-98 Carvair, made its first flight at Southend, England, June 21. Plane, piloted by Capt. D. B. Cartlidge, was airborne 2 hr. The Carvair is 12 ft. longer than the DC-4; maximum weight is 73,000 lb. Tradair said drag penalty of new nose is 12 mph. Ten Carvairs have been ordered by Channel Air Bridge for cross-Channel car-ferry and passenger operations. Cars are loaded through a nose door, under the raised flight deck. Aviation Traders said the airplane costs about $420,000. Carvair hauls five cars and 20 passengers.



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wing structure began almost simultaneously with the right wing separation and that separation of the right outboard powerplant installation began shortly afterward.

As previously mentioned, impact and fire damage to components of the various systems of the aircraft precluded functional testing of the majority of such items. However, detailed inspection of all recovered systems components, and functional checks of those items still capable of being tested, failed to disclose any evidence of operational distress or indication of malfunctioning of any component or system. The fuel dump valve and chute positions indicated that fuel dumping was not being attempted and the crossfeed valve positions were consistent with normal tank-to-engine fuel utilization procedures. Examination of the control surface boosters failed to show whether the autopilot was in operation or to indicate conclusively whether the boosters were in the "manual" or "boost" configuration.

Investigation of the powerplants revealed no evidence of malfunction or failure that contributed to the cause of the accident. Of the numerous items studied in detail, no one considered alone provides an answer as to the cause of the accident. However, the powerplants did provide information that can be correlated with other known facts and circumstances of the accident.

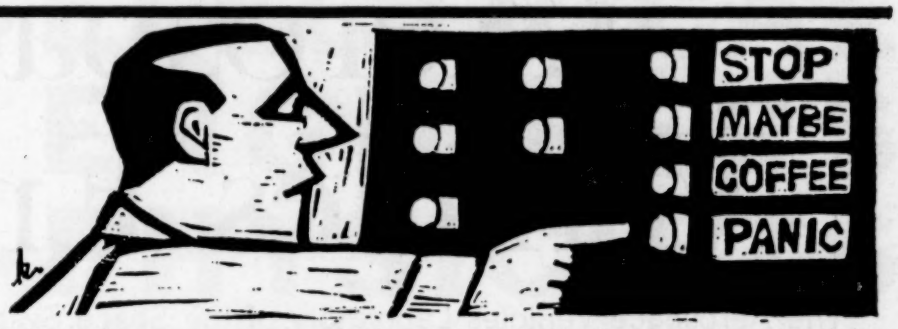
Circumstances of the separation within Nos. 1 and 4 engines are of primary significance and there are indications of similarity. The time interval between separations was very short, as evidenced by the locations where they fell and the trajectory studies with No. 1 separating first.

Obviously, abnormal loads were required to bring about these separations since there is a complete lack of evidence of any progressive fatigue failure to the point where separation occurred under normal loadings. Likewise, it is not conceivable that fatigue cracks would start and progress practically simultaneously to failure in two different locations on the two engines. Furthermore, there is no structural failure history of this model engine to suggest such an occurrence.

Aluminum deposits on the thermocouples and turbine inlet guide vanes of Nos. 1 and 4 engines are believed to be significant. Such deposits are expected on turbine engines when the compressor blades contact and machine away aluminum particles while the engine is operating. These deposits on the two outboard engines that separated in the air cannot be accepted as coincidental. It is believed rotational interference which resulted in the aluminum deposits was caused by air inlet and compressor case distortion due to abnormal loads being applied through torquemeter housing and struts of these engines. Furthermore, the abnormal loads followed disruption of the engine supporting structure so that loads normally taken out by the Lord mounts and QEC structure were imposed on the engine structure. It follows that the basic engine structure forward of the compressor must have been intact in order to transmit propeller generated case distorting loads.

A study of the pieces of the No. 1 reduction gear housing did not reveal any evidence of repeated contacts or movements of the parts; however, there were indications of changes in direction and a reversal of the relative motion of adjacent parts, specifically

PROBLEMATICAL RECREATIONS 75



A clock hangs on the wall of an Early Warning Display and Control Center, 71 ft. 9 in. long and 10 ft. 4 in. high. (Those are the dimensions of the wall, not of the clock!) While waiting for the waning crescent moon to rise we noticed that the hands of the clock were pointing in opposite directions, and were parallel to one of the diagonals of the wall. What was the exact time?

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System Test. To plan and supervise the operations of a flight control system laboratory. Air bearing tables and a wide variety of optical mechanical and electrical equipment are involved.

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If you are a graduate mechanical engineer, electronic engineer, physicist or aeronautical engineer, with experience applicable to the above openings, please airmail your resume to: **Dr. F. P. Adler,** Manager, Space Systems Division, Hughes Aircraft Company, 11940 W. Jefferson Blvd., Culver City 62, California.

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the part which includes the left strut eyebolt base and the adjacent piece which encompasses the left QEC to reduction gear mount pad, identified as pieces one and two, respectively. There are marks that were by the forward side of piece two moving in the outboard direction and scraping against two corners of the castellated eyebolt nut. The location of the marks also indicates that piece two moved a short distance downward and forward. Abrasion marks on the edge of the fracture at the lower rear corner of the left mount pad indicated a slight downward, forward, and twisting of piece two with respect to piece one. These marks probably were made at about the same time that the nut was contacted; subsequently, abrasion marks were made which indicated piece two moved upward and slightly toward the rear. These marks do not substantiate whirl mode; however, they are not inconsistent with what might be expected were whirl mode to be in progress as breakup occurred.

The fractures of the structure of the No. 4 engine did not reveal any markings which showed load reversals as separation occurred. The only indication of load reversals on this engine was at the front end of the compressor shaft extension where separation from the torquemeter occurred. Loadings on both sides of the splines, rearward upset of some of the spline ends, and light longitudinal markings in a rearward direction on some of the splines suggest some movement other than a straight pull away. Gross misalignment as would result from a whirling motion at the propeller, coupled with an r.p.m. differential between the two separating parts, is compatible with the markings.

Failure Areas

Examination and study of the aircraft structural wreckage narrowed the failure areas of possible significance to the inboard portion of the right wing, the outboard engine support structures, and the left elevator. This work also eliminated the probability of structural failure due to fatigue cracking, missing parts, nonconforming materials, and overtorquing of nuts.

Although the outer end of the left elevator disintegrated because of flutter, the wreckage distribution proves that this occurred appreciably subsequent to the right wing separation and shortly before the fuselage struck the ground. In addition, the trajectory calculations indicate that at the time of the elevator flutter the airspeed was much in excess of the design dive speed. As a result, the disintegration of the left outboard elevator was a consequence of the wing separation and cannot be considered an indication of unairworthy conditions prior thereto. The only remaining parts of the aircraft which appear to have been involved in the catastrophic disintegration are the wing and engine support structures.

As developed under investigation, a detailed study of the damage to the right wing structure between the fuselage and the inboard nacelle disclosed numerous indications of damage progression during rapid reversals of loading. The separation and upward buckling of the front spar cap flange from the vertical leg between stations 78 and 89 is one example. If this had occurred during a sustained up-gust or positive maneuver, it and the associated disruption of the wing

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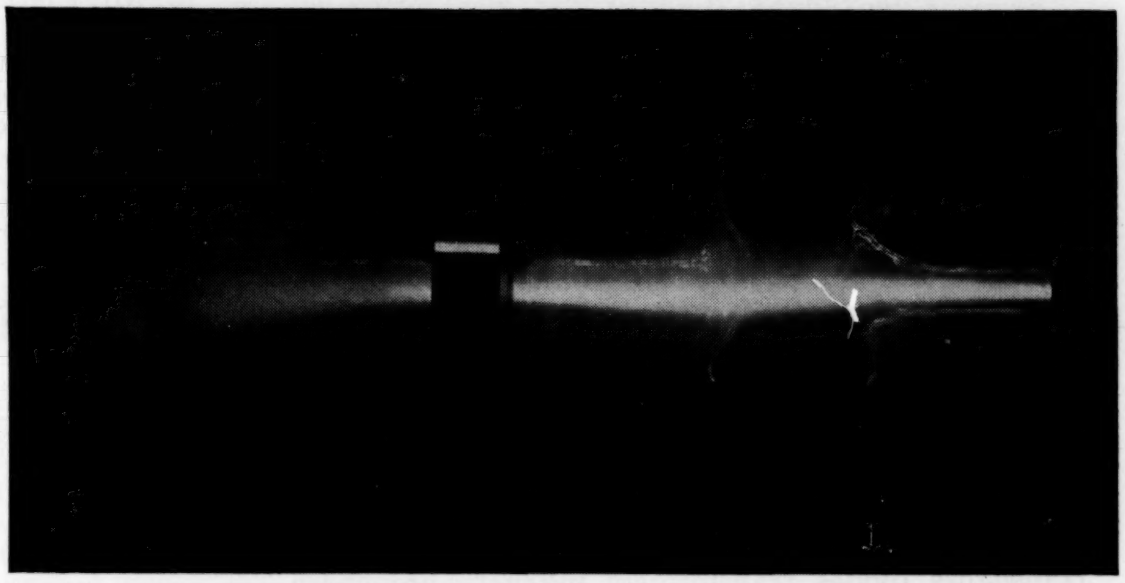

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Sr. Chemist or Chemical Engineer with experience in vacuum evaporation, vapor reduction, and electro-deposition of coatings on metallic and non-metallic base materials or experience with any of the coating methods. Must be capable of developing processes providing uniform adherent deposits of materials having unique properties suitable to advanced gyro and circuitry development.

Sr. Systems Analyst. Must be well grounded in math and have 4 years' experience in analysis of aircraft stability and control. Familiar with both analog and digital computers and capable of applying various types of stability criteria such as phase amplitude plots, root locus, etc. Broad experience in circuit design and closed loop servo-systems.

Transistor Circuit Applications. Experience in audio frequency circuit design or servomechanisms, circuits utilizing transistors, diodes, transformers, magnetic amplifiers, etc. Familiarity with military design requirements desirable.

Electronics Packaging Engineer. 2 years' experience in the basic development of microminiature devices or design of one or more types of electronic components such as semiconductors or resistors. Experience with military hardware requirements desirable.

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box upper cover could result only in the wing folding upward during separation from the fuselage rather than rearward as it did.

In this same area of the wing the previously discussed damage to the end ribs of the inboard hinged leading edge and the irregularly saw-toothed diagonal fracture lines in the bottom cover are further evidence of reversing loads, both bending and torsion. This type of damage progression appears to be consistent only with catastrophic flutter.

The rib and rib attachment damage found in this same area of the wing could possibly be entirely the result of abnormal reversing stresses associated with the flutter. However, the similarity of some of this damage to that found on other Electras after abnormal ground loading could be indicative of damage prior to the onset of flutter.

Support Structures

The detailed examination of the outboard powerplant support structures disclosed additional evidence of cycling in the form of damage due to repeated bottoming of the front Lord mounts, curved scratches on one of the swirl straighteners, and repeated interference of fractured surfaces. These, particularly the curved scratches on the swirl straighteners, are indicative of the propellers having oscillated violently for a short period of time prior to the gross over-all displacement which occurred during the disintegration of the powerplant support structure. The energy associated with this violent oscillation obviously caused rapid progression of damage to the powerplant support structure.

Insofar as this accident is concerned, one development of the reevaluation program is most significant. This is that on the Electra the previously mentioned propeller oscillation known as "whirl mode" can under certain conditions cause flutter and structural disintegration.

This is true despite the fact that all of the flutter tests and analyses made by Lockheed during the original certification process and during reevaluation showed the Electra to be flutter-free at and above normal operating speeds, and further disclosed that the wing has a high degree of damping. The latter means that an oscillating motion of the structure will die out rapidly when the exciting force is removed; the damping forces are those which take energy away from the oscillation. A small amount of damping is from internal energy absorption in the structure and in energy absorbers such as engine mounts. The most significant damping, however, is the result of aerodynamic forces acting in opposition, thus absorbing energy from the oscillation. Conversely, if a major change occurs that allows the aerodynamic forces to be additive to the exciting force, the oscillation grows and the result is flutter.

Since the Electra wing is basically flutter resistant, in order to produce flutter there must be an external driving force. The possible force generators are the control surfaces and the propellers. Analyses indicated that the control surfaces would not produce wing oscillations of sufficient amplitude to produce a failure, consequently further analysis was centered around the propeller.

Since the propellers are normally stabilizing, it was necessary to consider abnormal propeller behavior such as overspeeding and wobbling. The studies and tests conducted during the reevaluation program proved that a wobbling outboard propeller caused by a weakened nacelle structure can induce wing oscillations.

Since a propeller has gyroscopic characteristics, it will tend to stay in its plane of rotation until it is displaced by some strong external force such as turbulence, an abrupt maneuver, or power surge. When such a force or moment is applied, the propeller reacts in a direction 90 degrees to the force. For example, if the propeller is displaced upward, the resistance of the structure applies a nosedown pitching moment, causing the propeller disc to swing to the left due to precession. The yaw stiffness resists this motion causing precession downward, resisted by pitching stiffness which produces a precessional swing to the right. This, in turn, is resisted to cause an upward precession to complete the cycle. This effect is termed "whirl mode" and its direction of rotation is counter to that of the propeller.

Normally, whirl mode can operate only within the flexibility limits of the engine mounting structure, and is quickly damped. If, however, the stiffness of the supporting system is reduced through failed or damaged powerplant structure, mounts, or nacelle structure, the damping of whirl mode is reduced to a degree depending on the amount of stiffness reduction.

Potential Danger

Powerplant structural weakness or damage does not significantly change the conditions under which whirl mode may be initiated, but in three ways it makes the phenomenon a potential danger:

- **The greater flexibility** of a weakened system can allow whirl mode more freedom, hence it can become more violent. In an undamaged system the stiffness increases with increasing deflections, but this is not necessarily true if the structure is damaged.
- **In a weakened installation,** the increasing violence of whirl mode can further damage the supporting structure, in turn leading progressively to more violence and even further damage.
- **As the structural system** is damaged reducing the spring-constant, the amplitude of whirl mode increases and the frequency decreases from its natural value to lower values which approach the wing fundamental frequencies.

The natural frequency of whirl mode in an undamaged installation is approximately five cycles per second. The wing torsional frequency is about 3.5, and wing bending about two cycles per second, with some slight variation with fuel loading.

As whirl mode progresses in an overly flexible or damaged powerplant installation, its frequency can reduce from five to three cycles per second where it will drive the wing in three cycles per second torsional and bending oscillations. These wing oscillations will reinforce and perpetuate the whirl mode. The three oscillations are then coupled at the same frequency of about three cycles per second, thus becoming a form of induced flutter forced by a powerful harmonic oscillation. This phenomenon can exist, as demonstrated in wind tunnel tests and in analytical methods, at an airspeed far below that at which classical flutter can develop.

The stiffness factor for an undamaged powerplant installation is 15.9 x 10^6 inch pounds per radian (root-mean-square). The tests indicated that at this stiffness level, whirl mode cannot force wing oscillations at

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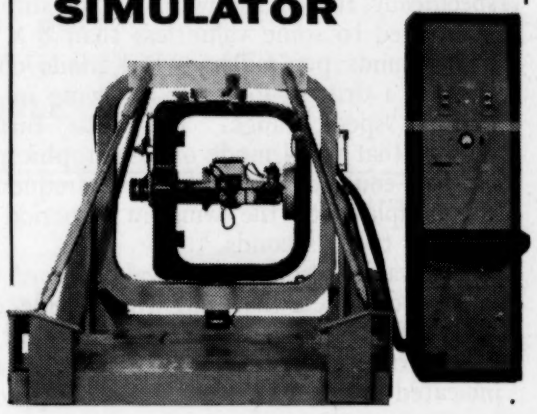

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any speed below 120% of the design dive speed of the aircraft. If, however, the stiffness is reduced, forced oscillations become more likely depending on amount of stiffness reduction and on equivalent airspeed. More specifically, the data show that if the stiffness is reduced to some value less than 8 x 10^6 inch pounds per radian, whirl mode could become a driving force on the wing in the cruising speed range. The tests further showed that whirl mode of catastrophic proportions could develop, reduce its frequency, and couple with the wing in a period of from 20 to 40 seconds.

In recapitulation, the re-evaluation of the Electra disclosed that the whirl mode can induce flutter in a wing highly resistant to flutter, trajectory studies disclosed that the indicated airspeed of N 121US was approximately 260 knots at the time of disintegration, study of the wreckage of N 121US disclosed that the right wing separation resulted from flutter, the outboard powerplant nacelle disintegrations involved oscillations characteristic of the whirl mode, and analysis of the weather at the time and place of the accident disclosed the existence of clear air turbulence which can excite the whirl mode. It must be concluded, therefore, that the whirl mode provided the driving force essential to destruction of the wing. However, the sequence of events that led to the whirl mode becoming destructive at normal operating speed is not established.

One possibility is that in penetrating the clear air turbulence, no single pulse of which could cause an overload, N 121US may have been subjected to a rapid succession of impulses at the proper frequency to cause dynamic response damaging the engine support structure and enabling the whirl mode to become self-sustaining. However, uniformly timed impulses with sufficient energy at the necessary frequency are extremely improbable in natural turbulence, which usually has the characteristic of being random both in frequency and in intensity.

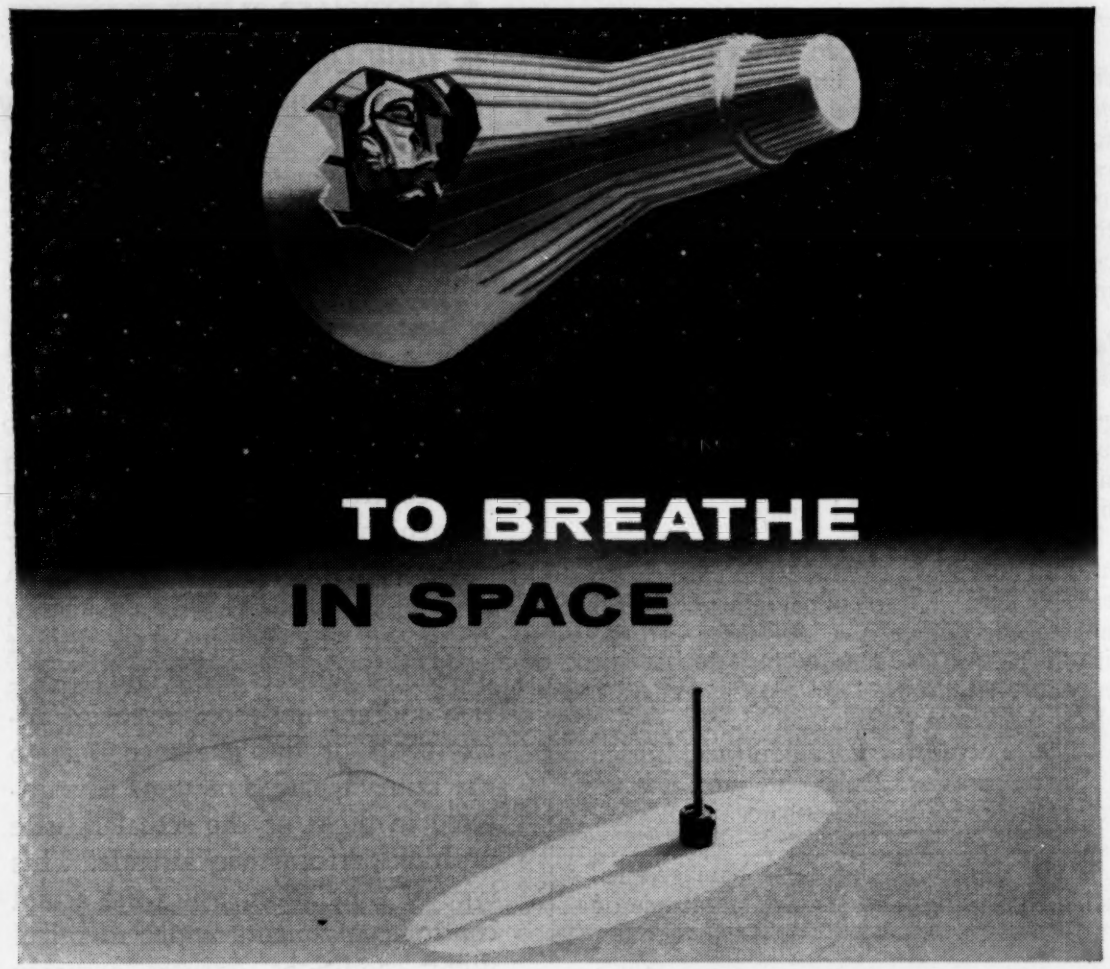
A second possibility is that there was sufficient prior damage in one of the outboard nacelles alone to reduce the stiffness to the range where, once excited by turbulence, the whirl mode was self-sustaining and rapidly became divergent. This possibility hinges on extremely severe prior damage, which does not appear likely to have escaped detection during the detailed examination and study of the wreckage.

A third possibility appears to be prior damage to the wing; for example, partially disrupted ribs, as suggested but not proved by the previously mentioned evidence of rubbing between mating parts found on separate pieces of wreckage. With such a condition, penetration of severe clear air turbulence in the area of Cannelton could conceivably result in rapid progression of wing damage. This could also cause change in the already more critical than expected dynamic response sufficient to damage the outboard powerplant support structures, thereby causing the whirl mode to become self-sustaining. Although extensive calculations by the manufacturer tend to discount the possibility of limited prior wing damage having any significant effect in this regard, no dynamic tests have been conducted to support the calculations. Due to the extremely complex interactions under dynamic conditions with damaged rib structure, it is concluded that only such tests of a full-scale structure could either prove or disprove this possibility.

Chicago Landing

The landing of N 121US at Chicago on the day of the accident may well have caused damage to the wing structure even though some of the passengers considered it a perfectly normal landing. This is due in part to the fact that a person senses only the resultant of the acting forces and that in parts of the cabin of large aircraft very high linear accelerations due to ground loads can be practically canceled by very high angular accelerations. In addition, drag and side impacts on the landing gear sufficient to cause structural damage are smaller than damaging vertical loads with the result that they can occur without alarm. This is borne out by one Electra accident where rearward-acting ground impact loads on the main landing wheels were sufficient to destroy one wing and to collapse the opposite main gear, but the occupants in general had no idea of anything being amiss until the fuselage assumed an extremely abnormal attitude.

In conclusion, the investigation has disclosed that the right wing failed due to flutter involving whirl mode oscillation of the outboard nacelles. Although contributory to the initiation of the flutter, the severe clear air turbulence above appears to have been insufficient to produce the nacelle damage necessary to make the whirl mode self-sustaining. It appears most probable, therefore, that there was unrecognizable prior damage in the wing, or in the wing and outboard nacelles, making the effects of



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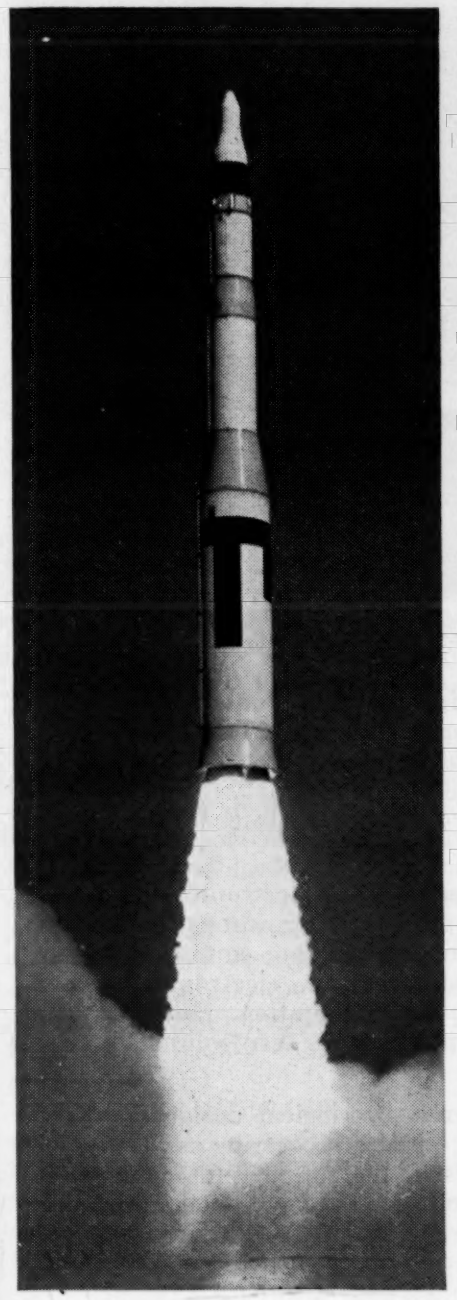

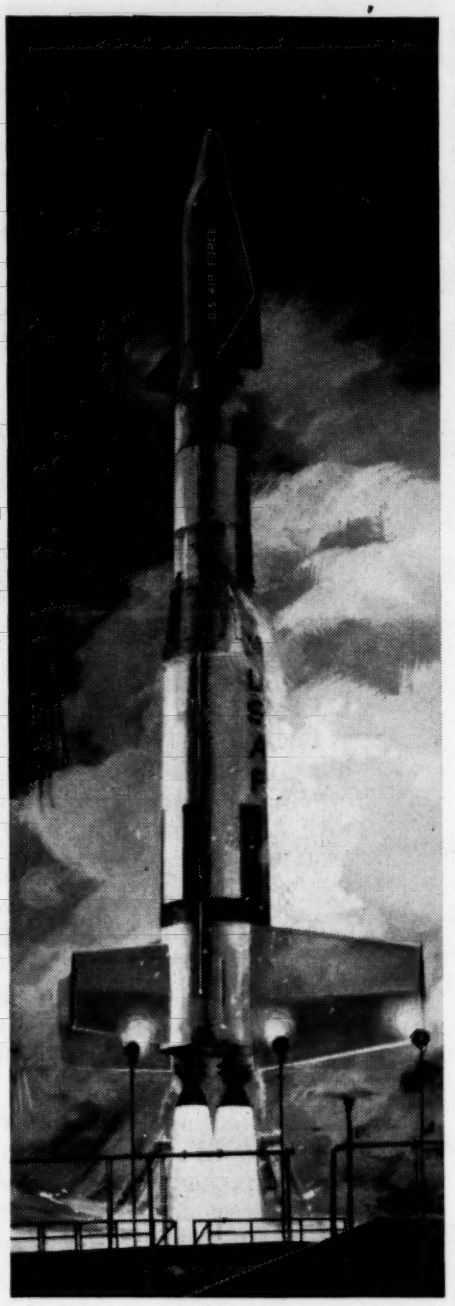

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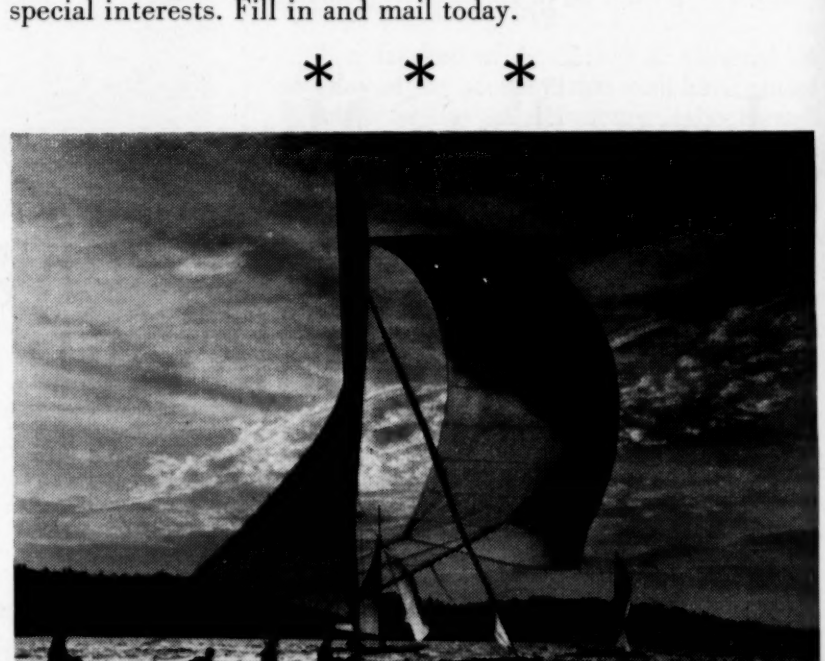

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the turbulence more critical than on an undamaged airplane.

The Board determines that the probable cause of this accident was the separation of the right wing in flight due to flutter induced by oscillations of the outboard nacelles. Contributing factors were a reduced stiffness of the structure and the entry of the aircraft into an area of severe clear air turbulence.

By the Civil Aeronautics Board: ALAN S. BOYD, Chairman; ROBERT T. MURPHY, Vice Chairman; CHAN GURNEY, Member; G. JOSEPH MINETTI, Member; WHITNEY GILLILLAND, Member.

Supplemental Data

The Civil Aeronautics Board was notified of this accident at approximately 1700 c. s. t., March 17, 1960. An investigation was immediately initiated in accordance with the provisions of Title VII of the Federal Aviation Act of 1958. A public hearing was ordered by the Board and held in Evansville, Indiana, on May 10 and 11, 1960, and in Hollywood, Calif., July 20, 21 and 22, 1960.

Northwest Airlines, Inc., is a Minnesota corporation with its principal office in Minneapolis, Minnesota. The corporation holds a certificate of public convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Federal Aviation Agency. These certificates authorize the carrier to engage in air transportation of persons, cargo, and mail within the United States, including the route involved.

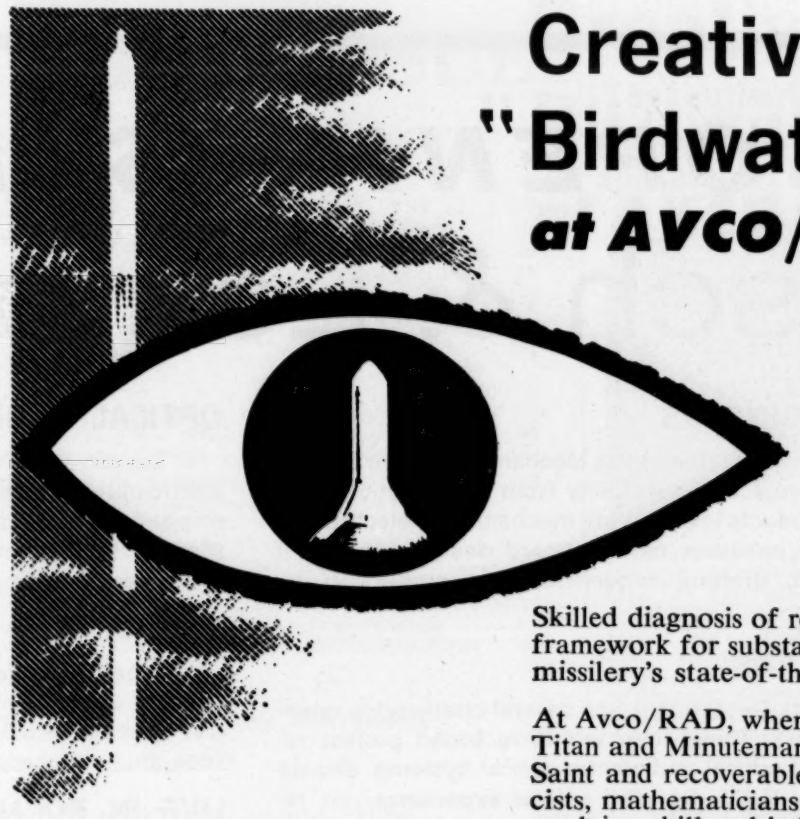
Captain Edgar E. LaParle, age 57, was employed by the company March 15, 1937. He was promoted to captain June 4, 1940. He held a valid FAA airline transport pilot certificate with ratings: AMEL, C-46, B-377, DC-3, DC-4, DC-6, M-202, and L-188 aircraft. He had a total of 27,523 flying hours, of which 254 were in L-188 aircraft. His last FAA first-class medical examination was taken December 7, 1959; no limitations or defects were noted. His last check flight in L-188 equipment was December 16, 1959.

First Officer Joseph C. Mills, age 27, was employed by the company on August 7, 1957. He held a valid FAA commercial pilot certificate with ratings: AS & MEL, B-25, instrument. He had a total of 2,974 flying hours, of which 200 were in L-188 aircraft. His last instrument check was December 6, 1959. His last FAA first-class medical examination was taken July 14, 1959; no limitations were noted.

Flight Engineer Arnold W. Kowal, age 40, was employed by the company March 19, 1942. He held a valid FAA flight engineer certificate and was qualified in L-188, B-377, DC-6, and DC-7 aircraft. He had a total of 5,230 flying hours, of which 63:36 were in L-188 aircraft. His last second-class FAA medical examination was taken January 18, 1960.

Stewardesses Constance M. Nutter and Barbara A. Schreiber and Flight Attendant Mitchell D. Foster were properly qualified.

N 121US, a Lockheed Electra, model 188C, was manufactured July 20, 1959. The aircraft had a total flying time since manufacture of 1,786 hours. The last major inspection was accomplished on March 9, 1960, 74 hours prior to the accident. It was equipped with four Allison 501-D 13 engines and Aero Products propellers, model A 644 FN-606.



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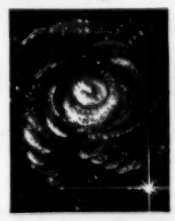

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DON FAIRCHILDS
Public Relations Manager
Ryan Electronics
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You are to be congratulated on your editorial "New Image at Paris" in the June 12 issue of AVIATION WEEK.

It would be the greatest tragedy in the world if Washington should abandon participating in the international air shows as a result of the B-58 accident. The full story of this accident may never be known. Your editorial sums up very aptly the feelings of most Americans in Europe, particularly those connected with the aviation business, of which I am one.

Personally, I would have liked to have seen the U.S. military acrobatic team at the show, too.

In our daily associations with members of the aviation industry in Europe since the show, it is quite apparent that the United States' broad participation has had a great impact over here, which will be felt for a long time to come.

ROY C. BRITEN
Lockwood, Briten & Co.
Geneva, Switzerland

Communication Faults

In his letter in the June 12 issue of AVIATION WEEK, H. W. Kretsch, Consolidated Controls Corp.'s chief engineer, complains about the size, the cost and the falseness of "glossy proposals." I agree; I half expected him to say that proposals "were not worth the paper they are written on." Considering the amount of paper used in proposals, this might have been an overevaluation.

Kretsch suggests that proposals be eliminated, relegated to the background or at least strictly limited in physical size. I disagree. The proposal, like many other forms of documentation, is an important means of communicating very valuable data from one group to another.

The reason proposals confuse rather than communicate is that they are now being "written" by people who have not the slightest idea of what a proposal is, nor how to prepare one. Proposals, like other documentations, will continue to be a maze of confusion until it is recognized that proposals are devices of communication, that communication is the work of professional writers and that everyone is not a writer.

There is evidence everywhere which suggests that one of our most critical problems is not getting more scientists, engineers and technicians—although we need many more—but in accurate communications between those we have. The failure of missiles on the launching pads can usually be traced to the failure of "getting the word" to some one. We are sending Kretsch a copy of "Go Write, Young Man," which we recently published.

We hope that it will explain the problem in greater detail, and will suggest some form of the answers.

We are very happy to see that AVIATION WEEK is aware of this problem.

MALDEN GRANGE BISHOP
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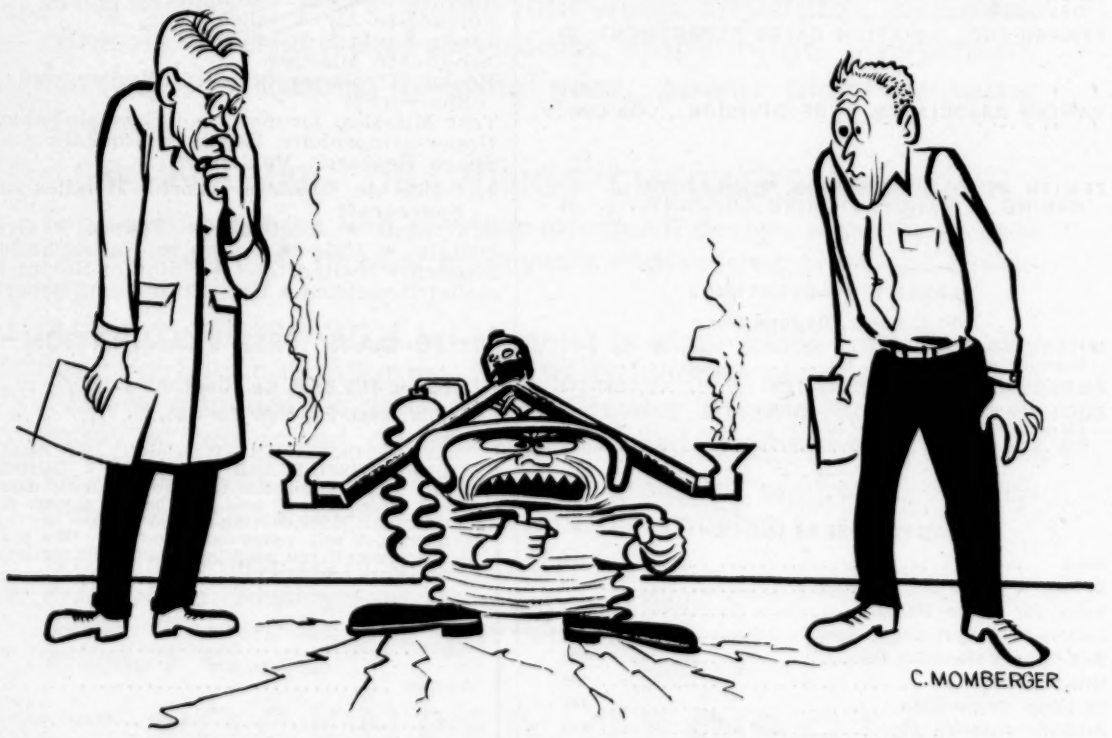
Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.



ALL RIGHT! WHICH ONE OF YOU WISE GUYS TURNED THE NOZZLES ?

Bell Aerosystems Division of Textron Corp. submits this self-spoofing cartoon on man-carrying rocket belts (see AVIATION WEEK, June 12, p. 33 for details).

Appalling Attitudes

Your editorial "The Too Familiar Pattern" in your issue of Apr. 24, is the best I have read. There should be some way that your article could be read and understood by all American people.

After working for the military from 1944 to 1951 and returning to the Middle West in 1951, I was appalled at the attitude of that area.

Coming to California in 1958, I again was appalled at the same conditions.

I think some way should be found by either the churches or different groups and organizations, as well as high schools and colleges, to impress upon them the workings of communism.

JEANNE Z. NEALE
Saratoga, Calif.

Ungodly Hours

The problem of luring passengers aboard airliners in the ungodly hours of the night is ascribed to the bleak wait the traveler undergoes at the airport between his arrival at, say, 2 a.m. and dawn.

The night-flight market is worth developing even at the cost of sharply reduced fares, in order to distribute fixed costs over a larger ticket base.

To take the woe out of the wait, why don't airport commissions authorize construction and lease of special facilities to the airlines, which the carriers could maintain for the passengers, at no additional cost to the latter? Two classes of service are needed, one for those who can catnap in strange surroundings, and another for those who would rather stay awake but want a livelier occupation than magazine-reading.

For resters, the provision of extremely compact, but not unattractively decorated, private sleeping cubicles, with radio outlets and with due provision for the security of their person and property would be a relief, compared to dozing on a main lobby bench.

An attendant would be needed on a 24-hr. basis (once the facilities are in there, use them round the clock) to change the one-time-use paper linens and provide general service.

A "little Las Vegas" approach might satisfy the other segment of the public, with free TV, card tables and shuffle-board equipment.

The major consideration is the inclusion of the services in the price of the night-flight ticket.

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